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THE BEET-SUGAR INDUSTRY IN ENGLAND.

By JOHN MILLS.

"AN equal appreciation of all parts of knowledge," says Humboldt, "is an especial requirement of the present epoch, in which the material wealth and the increasing prosperity of nations are, in a great measure, based on a more enlightened employment of natural products and forces." This truth, uttered half a century ago, is still applicable to our own times, in face of the many innovations which scientific men have introduced into everyday life. Obviously, if large areas of land in England were devoted to sugar-beet, in the localities most suitable, as to climate and other circumstances, for its growth, and factories were established for the manufacture of sugar from it, there would be greatly increased employment for the population. With regard to the suitability of the climate of the British Isles for the growth of beetroot in sufficient quantity, and, at the same time, of adequate richness in sugar, Mr. Sigmund Stein says: "The sugar contained in the home-grown beetroot is not only equal to, but even surpasses that contained in the beetroot grown on the continent of Europe." Referring to the beet-sugar industry of France, the United States Consul at Havre said, in a report last year, that "the crop pays the farmer better than wheat or any other agricultural product." England is often accused of being the only European State which is blind to its own interests, and certainly the sanguine supporters of the scheme for initiating a British sugar-beet industry are fortified with statistics and other evidence which, on the surface at any rate, seem to indicate that we are, in this respect, under the curse which ever clings to those who stand still. While other nations are thriving on a comparatively meagre production of beetroot, England is starving, so to speak, in the lap of luxury. Some idea of this state of things may be gleaned by an inspection of the following tables of results from the official statistics relating to Germany and France :—

GERMANY.

Years.	Number of Sugar Factories.	Area under Sugar-beet.	Produce of Roots per Acre.	Roots submitted to Manufacture.	Raw Sugar produced.	Raw Sugar per Cent. on the Roots.
		Acres.	Tons.	Tons.	Tons.	
1890-1	401	824,825	13·0	10,623,319	1,336,221	12·09
1891-2	406	861,583	11·4	9,488,002	1,198,025	12·06
1892-3	403	869,829	11·3	9,811,939	1,230,834	11·94
1893-4	401	954,995	11·1	10,644,351	1,366,001	12·34
1894-5	405	1,090,801	13·3	14,521,029	1,827,973	12·15
1895-6	397	930,749	12·5	11,672,816	1,457,057	13·11
1896-7	399	1,049,881	13·0	13,721,601	1,821,223	12·66
Mean	—	—	(12·1)	—	—	12·06

FRANCE.

1890-1	377	547,808	11·8	6,499,906	683,602	10·52
1891-2	368	551,955	10·2	5,628,804	642,023	11·41
1892-3	368	528,156	10·3	5,472,891	581,517	10·63
1893-4	370	543,645	9·6	5,250,192	571,987	10·89
1894-5	367	596,806	12·0	7,137,736	782,726	10·97
1895-6	356	505,858	10·7	5,411,484	659,607	12·19
1896-7	358	608,370	11·1	6,705,000	742,829	11·08
Mean	—	—	11·2	—	—	10·46

It will be noted that in Germany over a million acres were in cultivation in 1894-5, yielding an average of 13·3 tons of beetroot per acre, the mean produce for the seven years given being about twelve tons per acre, while the raw sugar obtained therefrom amounted to twelve per cent. The results relating to France indicate a poorer yield of roots, and a lower percentage of sugar, and while the factories in Germany remain practically constant there is a gradual reduction in their number in France. Now let us glance at the results of sugar-beet grown at Rothamsted, as set forth in the accompanying table, showing the quantity of the produce of sugar-beet per acre, with different descriptions and varying amounts of manure :—

Standard Manures.	Standard Manures and Cross-dressings each Year as under.			
	Series 1. Standard manures only.	Series 2. 550 lb. nitrate of soda = 86 lb. nitrogen.	Series 3. 400 lb. salts of ammonia = 86 lb. nitrogen.	Series 4. 400 lb. salts of ammonia & 2000 lb. rape-cake = 184 lb. nitrogen.	Series 5. 2000 lb. rape-cake = 98 lb. nitrogen.
	tons cwt.	tons cwt.	tons cwt.	tons cwt.	tons cwt.
14 tons farmyard manure	16 6	23 16	22 6	25 2	24 18
Superphosphate	5 18	19 11	13 9	17 15	16 5
Superphosphate and potash	5 18	18 17	14 19	22 3	17 17

Proceeding from left to right it should be observed that,

as indicated in the first column, farmyard manure alone gave an average of sixteen tons six hundredweight of roots; and the amount was raised to twenty-three tons sixteen hundredweight by the addition of five hundred and fifty pounds of nitrate of soda; to twenty-two tons six hundredweight by four hundred pounds of salts of ammonia; to twenty-four tons eighteen hundredweight by two thousand pounds of rape cake; and to twenty-five tons two hundredweight by rape cake and salts of ammonia together. Thus it is clear that by artificial means, as regards quantity, acre for acre, our own farmers could produce double the amount that either France or Germany have done in the past. When we point out that the crops at Rothamsted were not grown with the purpose of using them in sugar-making, the remarkable results given will appear still more worthy of attention to those who hope to make the sugar industry in England a means of resuscitating agricultural prosperity. For direct application to practice in the growth of the crop for sugar-making the amount of nitrogenous manures used were too large, and the distances apart from plant to plant were too great—conditions leading to over-luxuriance, and to imperfect maturing of the individual plants. In the face of all this it seems strange that the immense quantity of sugar consumed in the British Isles should reach us from abroad. Here are some figures relating to sugar-producing colonies:—

——	1891.	1892.	1893.	1894.
	cwts.	cwts.	cwts.	cwts.
Barbados	994,960	1,186,960	1,336,160	1,304,640
British Guiana	2,339,360	2,257,600	2,155,420	2,050,040
British Honduras	3,696	1,759	1,810	83 lbs.
Fiji	409,412	377,666	307,789	545,307
Jamaica	304,918	452,889	396,270	453,886
Leeward Islands—				
Antigua	241,820	306,040	291,240	304,840
Dominica	32,720	44,300	29,480	24,400
Montserrat	20,620	50,000	23,210	33,880
St. Kitts—Nevis	257,810	357,380	340,840	337,920
Virgin Islands	*nil*	160	80	60
Mauritius	2,442,734	1,831,176	1,693,020	2,723,057
Natal	52,272	210,769	240,713	265,680
Queensland	647,620	840,380	1,102,520	1,349,020
Trinidad	907,160	987,340	903,040	937,380
Windward Islands—				
Grenada	1,440	170	1,170	2,031
St. Lucia	70,762	114,928	88,746	89,698
St. Vincent	80,280	62,700	58,460	48,940

The value of sugar-beet roots depends not alone on the percentage of sugar they contain, but also on what is called the "co-efficient of purity" of the juice. If the percentage of dry matter in the juice were found to be sixteen, and that of the sugar twelve, as indicated by the polariscope, then the sugar would represent three-quarters, or seventy-five per cent., of the dry substance. In the following table is given Dr. Carl Stammer's data, in English terms, as to the value per ton of roots of the different percentages of sugar as shown at the head of the columns, each at the six different degrees of purity of juice.

Quotient of Purity.	Sugar in the Roots.						
	10·0 per cent.	11·0 per cent.	12·0 per cent.	13·0 per cent.	14·0 per cent.	15·0 per cent.	16·0 per cent.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
70	11 11	13 0	14 2	15 5	16 7	17 9	19 0
75	12 8	13 10	15 3	16 5	17 9	19 0	20 4
80	13 6	15 0	16 3	17 7	19 0	20 4	21 8
85	14 6	15 9	17 3	18 6	20 2	21 6	23 1
90	15 3	16 9	18 3	19 10	21 4	22 11	24 5
95	16 1	17 7	19 4	20 10	22 7	24 1	25 8

And so the lesson to be learnt from this table is, How great may be the difference in the value of the roots according to their composition!

Here is a table by M. Georges, showing the value per ton of roots for each percentage of sugar in the roots from thirteen down to seven:—

Sugar in the Roots.	Yield of Sugar in the Roots.	Proportion of the Total Sugar yielded.	Price per Ton of Roots.
per cent.	per cent.	per cent.	s. d.
13	8·53	65·6	19 3
12	7·82	65·1	17 7
11	6·99	63·5	15 9
10	6·22	62·2	14 1
9	5·38	59·7	12 2
8	4·61	57·6	10 5
7	3·88	55·5	8 9

A noticeable point in this table is the small proportion of the total sugar in the roots that is obtained in the manufacture; the amount being only 65·6 per cent., with thirteen per cent. of sugar in the roots, and as little as 55·5 per cent., with only seven per cent. in the roots.

One of the vital questions to consider in forming a judgment as to whether success would attend an extended growth of sugar-beet, and the establishment of factories for the manufacture of sugar in this country is, at what price of sugar is it probable that such an enterprise would be profitable? Mr. Stein estimates that four hundred factories, each costing about fifty thousand pounds, would supply all the sugar required for consumption in the British Isles. Going into more detail he says: "A sugar factory working forty thousand tons of roots, the crop of, say, three thousand acres, would produce about five thousand (five thousand two hundred) tons of sugar, and would cost to erect about sixty thousand pounds." Giving a summary balance sheet, he reckons there would be a profit of over six per cent. on the sixty thousand pounds capital, if the price of sugar were nine pounds per ton, of fourteen and three-quarters per cent. if ten pounds, of 23·4 per cent. if eleven pounds, and of thirty-two per cent. if twelve pounds per ton. The same authority reckons the cost per acre of growing sugar-beet at ten pounds, in return for which he will be able to turn out fifteen tons of roots at eighteen shillings per ton delivered to the factory, the roots themselves being estimated to produce 13·3 per cent. of sugar at a cost price of nine pounds per ton.

In any undertaking of this kind, a serious warning is afforded by the fate of Mr. James Duncan, who attempted this branch of industry between the years 1869 and 1873, at Lavenham, in Suffolk. It is said that with a requirement of at least thirty thousand tons of roots to work his factory profitably, Mr. Duncan finally could only obtain about seven thousand tons, due probably to the farmers not sufficiently modifying their rotations to secure an adequate supply of roots. Sir John Lawes and Sir Henry Gilbert* point out that it would require about six thousand acres, or more, according to the rotation adopted, to ensure the necessary supply to the factory in Mr. Stein's scheme, and "certainly not a step should be taken towards the establishment of a factory until the necessary supply of roots had been assured." Also for climatic and other reasons these observers think that, so far as the production of the roots is concerned, it could only be a success over limited areas, not Great Britain generally. Great caution should be exercised in the choice of the localities, Norfolk and Suffolk, it is alleged, having the most suitable climate, and the soils should be of a medium character—neither too heavy nor too light.

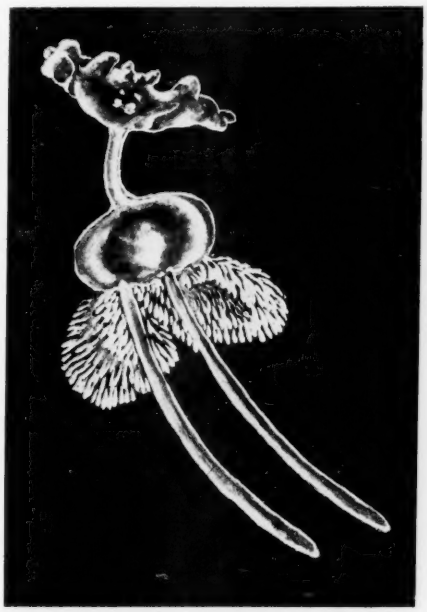
* A Pamphlet—"The Growth of Sugar Beet and the Manufacture of Sugar in the United Kingdom."

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—VI.

By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S.

IN the preceding chapter the Copépoda were spoken of as a resourceful group. No stories of preternatural ingenuity on the part of individuals can be told in support of this character. Seeing that they must be welcome and easily obtainable food to almost every kind of aquatic animal, and that they are massacred wholesale to fill the maw alike of sardine and cetacean, no humane person could wish them to be very highly endowed with sense and sensibility. But their individual helplessness is pretty solidly compensated by qualities which safeguard the existence of the community. They share with many other animals, higher and lower, larger and smaller than themselves, a surprising fecundity. But they are not content with this sort of mildly domestic defence against extinction. They turn upon their devourers. They take up their lodgings in the enemy's camp. They infest his skin. They invade his eyes and his very mouth. They enter joyfully into the spirit of Samson's riddle, "out of the eater came forth meat, and out of the strong came forth sweetness." They avenge the wrongs of their ancestors and their cousins by sucking the blood of almost every fish that swims.

In correspondence with the extraordinary variety of their dwelling-places, the parasitic and semi-parasitic Copépoda present a marvellously varied array of forms, ranging from those which nearly or altogether resemble the independent species, through countless gradations, to the eccentric, the

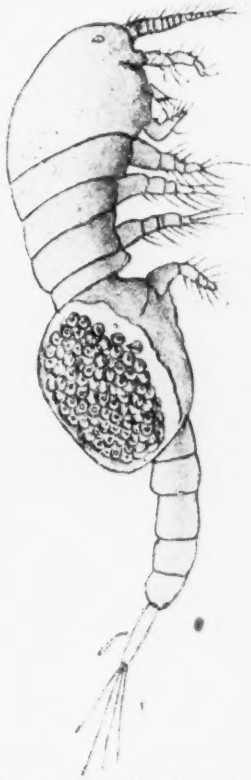


Sphyrion lævigatum (Quoy and Gaimard). M.A.S.

abnormal, the shapeless, the unrecognizable. The recognition of the unrecognizable may sound mysterious. The key to the mystery is this, that of father, mother, and children, it is usually only the mother that is absolutely self-sacrificing in her indifference to any thought of personal vanity when the welfare of the race is concerned. In return for this it is the mother that chiefly attracts the attention of science by quaint peculiarities of form. The mother, too, is distinguished by her respectable proportions, being in some instances no less than thirteen times as long as her diminutive husband.

According to the Danish writers, Steenstrup and Lütken, the mode in which the eggs are carried furnishes a useful classificatory character. There is one series of genera in which the two egg-sacks are filiform, thread-like, and the eggs in each are flattened and packed one over the other like a long roll of minute coins. In the other series the egg-sacks are much more sack-like, the eggs are more or less globular, and, though the packing is always as neat as possible, it is not limited to a single line.

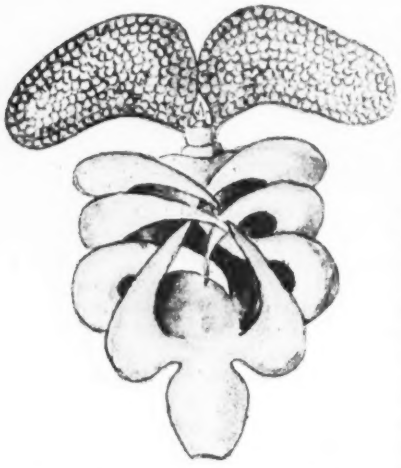
Among the free-living Copépoda, the Gymnoplea (noticed in the preceding chapter) as a rule do without an egg-sack or are content with only one, while the Podoplea, to which the parasitic forms may be affiliated, generally have a pair of these so-called sacks. The semi-parasites of the family Notodelphyidæ present a curious exception. There is here no external ovisac, the ova being matured in a pouch formed by the integument of the enlarged fourth segment of the thorax.* Sometimes, it should be added, the fifth segment of the trunk is utilized for this purpose. These animals, which, as the family name implies, have the matrix on the back, are found unattached and moving freely about in the branchial vesicles or body cavities of Ascidians. For this reason one of the genera has been named *Ascidicola*. The Ascidians are an accommodating set of creatures. They take in lodgers of many kinds, and especially they are an important hunting ground for those in search of Copépoda. Even species capable of living in freedom, and carrying free ovisacs, are not unfrequently found in Ascidians. They also shelter the Enteropsidæ, which are not free living, but yet have free ovisacs. Dr. C. Aurivillius, who established the family, found that in every case the full-grown mother of his *Enteropsis sphinx* was, along with its egg-bags, encapsuled, as it were, in folds of the branchial sack of the Ascidian. Thus the eggs are protected by the host itself, just as well as they are in *Notodelphys* by transfer to the mother's back. As Aurivillius points out, this is but one more instance of Nature's inventive genius applying to a single purpose manifold means. *Enterócola erúca*, Norman, actually condescends to live in an Ascidian's intestine, which seems to be carrying condescension rather far, and to be beneath the dignity of a crustacean. But odd things happen in the competition for a livelihood. Other species live in Mollusca. One, which abides in the common cockle, is specifically known as "agile," though



Notodelphys agilis, Thorell. From Brady.

* G. S. Brady, "British Copépoda," Vol. I., p. 123.

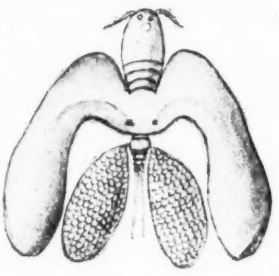
the sphere of its activity is so limited.* Another,† which is at home with the horse mussel, is said to have both body and ovisacs coloured of a brilliant red, thus pleasingly harmonizing with the orange-coloured body of its red-footed host, like a polite lady choosing her costume to match the furniture of a friend. A species described by Messrs. T. and A. Scott as residing in a nudibranch mollusc is branded by them with the specific name of *insolens*.‡ It certainly takes liberties with its host far beyond those which the commensal and semi-parasitic forms allow themselves. In this case the authors tell us that they found the parasite "entirely buried in the body of the mollusc, with the exception of the last abdominal segment and the ovisacs." Even when it was dug out, no antennæ or mouth-organs could be discerned. The clasping organs of the embedded trunk are shown by the figure to be of a quite unexceptionable tenacity, as little likely to let go when once fixed as the teeth of any bulldog. Echinoderms, annelids, sea-feathers and various other zoophytes, give lodgings to the Copépoda. The latter also readily take up with other crustaceans, not on any terms of friendship, but merely to suit their own convenience. One species lives with a hermit crab, and is difficult to capture from the wiliness with which it conceals itself within or underneath the shell occupied by the hermit.



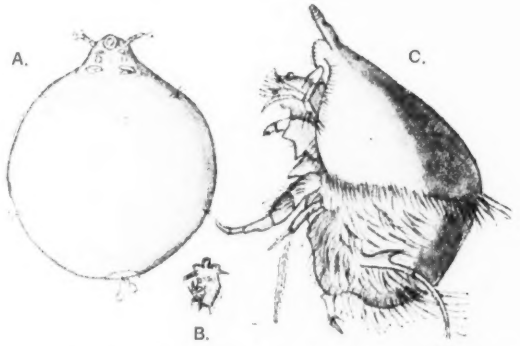
Lomanoticola insolens. From A. Scott.

One of the most frequently described species is the little *Nicothoë astaci*, Milne-Edwards and Audouin, so commonly found on the gills of the common lobster. This, when magnified, is seen to have the ordinary *Cyclops*-like form, only disguised at first glance by the enormous pair of lateral expansions at the fourth segment of the trunk. Its residence makes it more accessible to an inland observer than most of the marvels in this branch of study. Its size alone should endear it to the possessor of a good microscope. Within a total length of two or three millimètres he will find a series of appendages almost in all respects comparable with those of the large fish-parasites presently to be described. But while all this regular apparatus needs skill and care and a good instrument for making out its details, the most remarkable features of the animal are tolerably plain even to unaided vision. Attached to the front segment of the tail-part are two relatively enormous bags of eggs. It is with these that the monstrous lateral expansions of the trunk are deeply and doubly concerned. Not only do they form a protecting arch over the ovisacs, but it is from them that the rosy eggs as well as the bags that contain them are derived. Inside each of the great cylindrical outgrowths can be seen a faintly rose-coloured structure, which is the ovary, and below this a whitish gland, the source of the cement which forms the ovisac. The great carcinologists, Henri Milne-Edwards, Henrik Kröyer, and Heinrich Rathke, have all studied with admiring care this minute but remarkable organism.

Far more difficult to find and difficult to examine are the Choniostomatidæ, which like *Nicothoë* are parasitic on Malacostracan crustacea. Their name signifies that they have a funnel-shaped mouth. Eyes they need not. With antennæ they are provided, though the second pair is sometimes missing. They have mandibles, two pairs of maxillæ, and one of maxilliped. In the matter of trunk-legs Nature has here been thrifty, giving them in some instances none at all, in others two pairs with occasional indication of a third. The body shows no segmentation. Trunk and tail-part are compounded into a sort of globular mass, from which even the head is not always very precisely distinguished. There are females in this family capable of laying as many as twenty-eight packets of eggs, and of becoming a thousand times as big as their amiable spouses. The female herself, in giant species, is never known to be fully a quarter of an inch long, and in species that are not gigantic, can dwindle to about a twenty-fifth part of an inch. When such creatures have to be looked for in the branchial cavities of small Cumacea, or among the eggs of Amphipoda, the patience and discernment of the naturalist are put to a high test, and the chief encouragement to a beginner for tackling the Choniostomatidæ lies in the luminous English work on the subject by the Danish writer, H. J. Hansen. Some idea of the general form and the comparative sizes of male and female may be gathered from the subjoined illustrations, though they do not pretend to reproduce the delicate finish of the originals.



Nicothoë astaci, Milne-Edwards and Audouin.



Sphæronella elegantula, Hansen. A. Female, × 27; B, Male, × 27; C, Another male, × 143. From Hansen.

Lest the reader should feel his imagination cramped by too long dealing with objects inordinately small, he may now be invited to explore a larger field, and, for that purpose, to provide himself with a few freshly-caught sturgeon, thunnies, sharks, sword-fishes, conger eels, sun-fishes, and fishing frogs. Of the so-called fish-lice, the

* *Lichomolgus agilis* T. Scott.

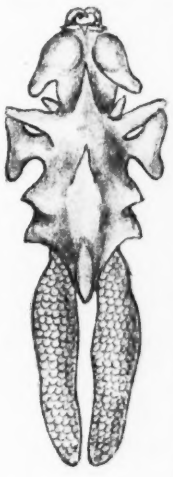
† *Modiolicola insignis*, Aurivillius.

‡ *Lomanoticola insolens*, T. and A. Scott.

majority of which are Copépoda in disguise, some attain to relatively large dimensions. Many of them are perfectly symmetrical, differing from the free-living types most obviously by the flattened body with its diverse flaps and skirt-like expansions, and by the suctorial mouth which gives to the whole group its title Siphonostoma. Others carry bizarre monstrosity to such an excess that all typical shape and structure are blurred or lost in a kind of travesty and caricature.

Caligus torpedinis. From Heller.

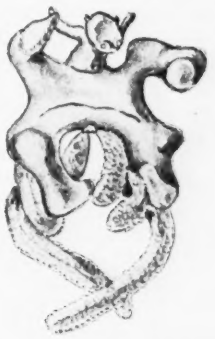
For study, the species *Caligus curtus* (Müller), common on the cod, and *Lepeophtheirus salmonis*, Kröyer, from the salmon, may be commended because they are easily attainable. Viewed from above they show two principal sections separated by a more or less wasp-like waist. The upper section is the cephalo-thorax with three of the trunk segments in coalescence. Behind this is the free fourth trunk-ring, followed by the lower section, which consists of the large genital segment, the terminal segment, and the usual setiferous caudal fork. On the back of the cephalo-thorax are two minute eyes, and at its top the first antennæ. Underneath will be found the second antennæ, hook-like. There are supplementary hooks on either side of the mouth, which is made up of the two lips and the mandibles, and goes by the name of rostrum or siphon. Outside it are a pair of "palps." Then follow two pairs of maxillæ and a horny "furcula." The three trunk-segments have three pairs of swimming legs to correspond, the broad flap-like expansions at the base of the third pair being especially conspicuous. The fourth segment has a slender pair of legs. To the genital segment in the female are attached the long pair of egg-strings. Between the two genera above-mentioned there is a distinction easily perceived. In the *Caligus* only will be found a pair of sucker-disks, which from their brightness and their position on the front margin were not unnaturally at one time supposed to be the creature's eyes.



Chondracanthus horridus. From Heller.

Such forms as the above can fix themselves with tenacity; can move over their hosts with freedom; and can swim with vigour in the open water. Under these circumstances, a fish, having no hands, is deplorably incompetent to decline or to dislodge his unbidden and unwelcome guests. Specimens of several genera batten on the unwieldy sunfish. The parasite of the sturgeon, *Dichelestium sturionis*, Hermann, is much segmented, and has no leaf-like expansions. With it, in the first respect, may be contrasted the *Strabax monstrosus* of Nordmann, which, in the female, has no segmentation at all. *Chondracanthus horridus*, Heller, which resides in the Mediterranean on *Gobius jozzo*, is symmetrical, if nothing else. On the other hand, *Diocus gobinus* (Fabricius) is so far from pretending to symmetry that, but for the long twisted egg-sacks, it might be supposed to be only a piece of protoplasm dancing the Can-can.

As in all other parts of the subject, so here, only a selection has been possible of a very few out of many competing topics of interest. Of the parasitic Copépoda a great number are known, but probably a vast number remain to be discovered, the chances being that almost every new fish, if properly examined, would yield a new parasite. It will not, perhaps, be easy to discover a more singular form than the *Sphyrion lævigatum* of Quoy and Gaimard, which has been taken from time to time in the Southern Hemisphere. In the earlier half of this century so little was known of its real character that, so lately as 1843, it was mixed up in a heterogeneous group of "zoophytes" with echinoderms and worms and polyps and infusoria. It is now known to be one of those "oar-footed" crustaceans which have neither oars nor feet, and which live with their muzzles buried in their favourite fishes. This epicurean existence seems to favour eccentricity of structure, and for those who desire the grotesque and the unfamiliar there may still be as good parasites in the sea as ever came out of it.



Diocus gobinus (Fabricius). From Steenstrup and Lütken.

SELF-IRRIGATION IN PLANTS.—III.

By the Rev. ALEX. S. WILSON, M.A., B.SC.

RAIN in its passage through the air dissolves small quantities of ammonia, nitric acid, and other substances, and this is no doubt an additional gain to plants which collect and accumulate rain-water in proximity to their roots and other parts where absorption occurs. The water that gathers in leaf-cups especially is likely to contain materials useful to plants, since it is often quite brown with the remains of insects that have fallen in and been drowned.

To creeping ants and beetles water presents an impassable barrier. For this reason, when a gardener wishes to protect a plant from their attacks he puts it on the top of an inverted flower-pot and places this in the middle of a flat dish containing water, where it stands, as it were, on an island inaccessible to the ants, many of which perish in their ineffectual attempts to reach it. Similarly, the water in the leaf-cups of the teasle surrounds and isolates the stem; the leaves and flowers are protected as by a moat from the attacks of creeping insects.

Although such protection is perhaps their original use, leaf-cups in many instances appear to have assumed an additional function. Mr. F. Darwin has observed that certain hairs in the leaf-cups of the teasle emit protoplasmic threads into the water; this also occurs in the case of Silphium. As filaments exactly similar are emitted from certain cells in the little traps of the toothwort, now regarded as a carnivorous plant, there can be little doubt that leaf-cups serve to some extent like the pitchers of Nepenthes and Sarracenia for capturing insects, and that they consequently furnish the plant with an important source of nitrogen. This view is confirmed by the frequent presence of putrefactive bacteria in the water of leaf-cups. It has been found that when a drop of water containing carbonate of ammonia in solution is placed on a leaf, after a time both water and salt disappear. Leaves as well as roots therefore take up ammonia, and this explains why

plants which have no true power of digestion are yet benefitted by capturing insects; from the decomposing bodies of their victims products are evolved which the plants are able to assimilate.

The water-vessels of the Bromelias and allied epiphytes, which often contain half a pint or more of water, are particularly interesting. The hollow leaf-base in some of this group of plants is a veritable aquarium. The water which accumulates in these curious receptacles Fritz Müller found to be inhabited by caddis-flies, entomostracans, and aquatic beetles belonging to species not occurring elsewhere. A small frog even takes up its abode among the bromelian leaves. Species of Utricularia also occur—small aquatic plants which capture in their curious little bladders the tiny crustaceans inhabiting the water in the bromelia leaves where they grow! *U. nelumbifolia* in this way grows in the leaves of Tillandsias, which are themselves epiphytes on the branches of other plants.

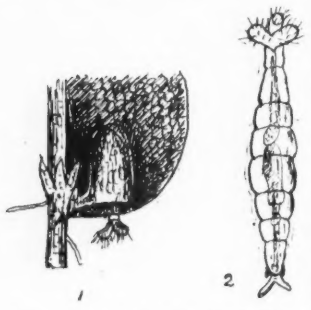


Fig. 1.—Rotifer inhabiting the hood of a Scale-Moss. (After Kerner.)

The term symbiosis is applied to those curious relationships in which we find two organisms of different kinds living together in partnership for mutual benefit and protection. A remarkable example of such symbiotic association is afforded by certain rotifers which take up their abode in the pitcher-like leaflets of some Jungermannias. One of these liverworts (*Frullania dilatata*) growing on the bark of species of Acer has hollow appendages of this description in which the water is retained by capillary attraction. In each of these pitchers a rotifer (*Callidina symbiotica*) takes up its quarters, finding in this retreat food and shelter. The association in all probability is one of mutual advantage; the rotifer is supposed to make a return to the plant for its entertainment in the shape of excrementitious products.

The case of these liverworts and rotifers is particularly interesting in connection with some recent observations made by the writer. In making sections of the chickweed stem to examine the origin of the lateral rootlets referred to in the preceding article, it was noticed that there frequently appeared on the slide specimens of the slipper-animalcule, Paramœcium, for whose presence it was difficult to account. So frequently did this infusorian put in an appearance that at last the idea suggested itself of its being a regular inhabitant of the water that gathers in the leaf axils of the chickweed. The examination of a number of specimens left little doubt as to the fact of this organism as well as several others frequenting the leaf axils of the plant in question. On submitting water from the leaves of a number of other plants it became apparent that leaf axils are rather favourite resorts for the minuter forms of life. Rotifers or wheel-animalcules, infusorians, monads, desmids, diatoms, micrococci and bacteria are of common occurrence. Paramœcium appeared to be rather characteristic of the chickweed, but was also present in the leaves of the sow thistle. In the leaves of the latter we also found that beautiful, lily-like infusorian the bell-animalcule, Vorticella cyathnia. Rotifer vulgaris occurs more or less frequently in the axils of the self-heal and ox-eye daisy. In none of the leaves examined could entomostracans be detected, although Cypris and other copeopods abounded in pools close to where the plants grew. The absence of the latter may be due to their size, entomostracans being very much larger than rotifers.

Although most of these organisms are to be found in all sorts of places where rain-water collects, their abundance in the tiny droplets that lurk in the leaf-axils of the plants just mentioned affords an interesting illustration of how Nature crowds her canvas, striving to utilize every nook and cranny that offers to living things the least coign of vantage.

Infusorians and rotifers, as is well-known, may be dried and reduced to powder without losing their vitality. After they have lain dormant for months the addition of a little water at once recalls them to life and activity. It is, therefore, in the highest degree probable that in their desiccated state they get blown along with dust into the axils of the leaves, and are revived by the water that trickles down into their resting places after a shower. Still, in the case of the rotifers, at least, there is another possibility. The wheel-animalcules are exceedingly active little creatures. Their mode of progression somewhat resembles that of the worms, with which they have close affinities. Mr. A. R. Wallace mentions in his "Travels on the Amazon" the remarkable fact that in some parts of Brazil, during the wet season, when the lands where they live are flooded, the large earthworms ascend trees and take up their abode in the hollow leaves of a species of Tillandsia, where they are often found accumulated by thousands. There is therefore nothing at all improbable in the idea that a rotifer may reach its station in the axil of a leaf, like these South American worms, by climbing.

Although only bearing remotely on the present subject, we may recall the case of Rosa Banksiæ, Acacia spadicigera, and other myrmecophilous plants where the hollow leaf-bases form the headquarters of the garrisons of ants by which these plants are defended.

The facts now referred to go to support the view of Kerner, that in those plants where aerial absorption occurs the object may be not so much security against drought as to obtain a supply of nitrogenous materials. Both ends are probably attained, for leaves, as we have seen, are capable of assimilating compounds of nitrogen. But whether the absorption take place at the roots or at the leaves it is evident that contrivances for promoting self-irrigation are all the more important on account of the nutritive salts which rain-water may hold in solution.

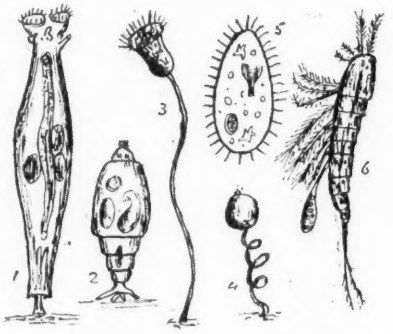


Fig. 2.—Animals inhabiting the axils of leaves. 1 and 2, Rotifer vulgaris; 3 and 4, Vorticella; 5, Paramœcium; 6, Entomostracan.

The prevalence of micro-organisms in leaf-axils suggests a probable origin of the carnivorous character; and though it may be difficult or impossible to establish a truly symbiotic relationship between any of them and the plants on which they live, these observations, nevertheless, touch the threshold of a large, inviting subject, practically unexplored.

PROGRESS IN RADIOGRAPHY.

By JAMES QUICK.

WHEN, at the end of 1895, Röntgen reported the results of his experiments upon the photographic action of those invisible rays he was then working with, he could hardly, perhaps, have anticipated the widespread interest that was evinced upon the subject, or the extensive work that has been done and is now being carried on, throughout the world.

Probably few discoveries have been of so much service to scientific workers in general, or have claimed such universal attention, as that of the properties of the Röntgen rays.

The selective transmission of the rays being their prominent feature, the most powerful aid was, of course, given to the medical practitioner—especially to the surgeon—in localizing accurately, and without the slightest pain or inconvenience to the patient, any foreign body in the system, especially if that body be of a dense nature, such as lead or steel.

Radiography has, therefore, become quite a recognized addition to hospital work and to surgeons, and in some cases where the hospital has not been so equipped, systematic work of diagnosis has been undertaken for its physicians by the college or other scientific institution in the same town. Two sets of Röntgen ray apparatus were also provided for the Sudan expeditionary force.

The benefit derived by Röntgen's discovery, both to the doctor and to the patient, cannot be over-estimated. Many a patient, having had a foreign body somewhere in his system, or sustained a bone fracture, has afterwards left the hospital showering blessings upon the surgeon for having utilized the radioscopical or radiographical method for extraction or coaptation.

Every part of the human skeleton has now been successfully dealt with radiographically, the amount of definition obtainable depending upon the proximity of the part in question to the skin, and therefore to the plate. As the thickness of the tissues through which the rays have to pass increases, so their transparency diminishes, but, according to Batelli, not at an equal or uniform rate, while Vandevyver has shown that the necessary exposure varies as the cube of the thickness of the object, and also depends on the distance (and not on the square) of the distance) between the focus tube and the sensitive plate.

Not only have X-ray pictures of the various portions of the body been taken at successive exposures and fitted together, but Dr. W. J. Morton has succeeded in obtaining, at one exposure, a life-size radiograph of the entire skeleton of a full-grown living woman—a most remarkable achievement and a striking picture—even the heart and other soft tissue organs being visible. The apparatus employed was a twelve-inch coil, worked from a one hundred and seventeen volt circuit. The distance of the focus tube from the plate was four feet six inches, and the time of exposure, including stoppages, thirty minutes.

In reviewing the work done by medical practitioners in this important and fruitful field for X-ray work, the number of successful cases would make by far too long a list to be adequately dealt with now. It is in the treatment of fractures and luxations, and in the detection and removal of the various calculi and other foreign growths and deposits that the most useful work has been done. Under the best adapted working conditions of apparatus for any particular case, the surgeon can examine with ease the exact condition of a fracture, or can ascertain how far reduction and fixation have been satisfactorily performed—even without disturbing any necessary splints or bandages. No difficulty is experienced with the former if they are made of wood or aluminium, or with the latter provided they are not soaked with lead lotion, or dusted with iodoform, both of which are impervious to the rays.

Until some twelve months ago, the accurate localization of different foreign bodies in the system was a difficult matter. This question, however, has been taken up—particularly by Mr. Payne and Dr. Mackenzie Davidson—and methods have been devised whereby the examination of any case by the surgeon has been much simplified. That of Dr. Davidson deserves attention as it is so simple and ingenious. With the necessary apparatus the exact position, to one hundredth of an inch, of an object can at once be found, the complicated geometry required by some other methods being simplified down by the apparatus itself and reduced to the application of callipers and a divided scale. Two exposures are made with the focus tube shifted through a certain distance, and the mechanical factors are reconstructed by the employment of fine threads, the position of which corresponds to the path of the X-rays. Fortified with this beautiful method the surgeon can now deal with many cases in much shorter time than was hitherto possible, and interesting reports have come to hand of the localization of bullets in the brain and eye, besides many other results.

With regard to the various calcareous deposits in the system, localizing the vesical calculi has been from the first a comparatively easy matter. Owing, however, to the position of the kidneys—close to the vertebral column—the depth of the cavity, and the thickness of overlying tissue, it was thought, at the earlier stages of the work, impracticable to obtain a radiograph of renal calculi, although, in the *Lancet* for 11th July, 1896, a case is reported by Dr. J. Macintyre of his having found, radiographically, a deposit in the position of the kidneys which, upon operation, proved to be a calcareous mass. A more interesting case, however, of renal calculi is reported by Dr. C. L. Leonard, the age of the patient being nineteen years. The radiograph was made with a twenty minutes' exposure, with the anti-cathode of the vacuum tube placed at a distance of twenty inches from the plate. An eight-inch spark coil was used. The successful operation performed proved the correctness and value of the diagnosis.

Amongst the many advances that have been made in radiographing the soft tissues, MM. Remy and Contremoulin report having devised a process, based on the deposition of chromate of silver within the tissues of anatomical preparations, which gives striking results in respect of mapping out the structure of the soft parts, while at the same time the bones are more distinctly marked out than they previously have been, so that sesamoid bones hitherto unknown have been discovered.

The action of Röntgen rays, however, is not only manifested in such cases as instanced above. Experiments show that they exert an influence upon the epidermis of the skin if exposed to them, sometimes causing local inflammation, and this action may occur even deep-seated within the tissues. The heart also, in some cases, appears to be affected when exposed to the action of the rays, insupportable palpitations and violent and irregular heart beats being produced, necessitating the complete sheltering of the heart by a thick metal shield.

In chemistry, botany, mineralogy, and other departments their properties have been discovered and applied. Their application to the detection of false gems is now well known, and a good deal about other allied results are obtained which open up interesting fields for investigation.

XUM

Turning to the practical methods of working, one finds that, in the main, apparatus of the same principle as that used at the first stages of the work is used now. The improvements and modifications have been made principally in the domain of constructive detail rather than by employing different methods. The induction coil method of exciting the X-ray tube is still used by the majority of workers—some of whom use coils giving as much as eighteen or twenty-inch length sparks in air, although this by no means infers that successful work has not been done or cannot be done with coils of far smaller magnitude. Coils giving three or four-inch sparks in air are quite sufficiently large for obtaining perfect radiographs of the extremities of the body, such as the hand, the ulna and radius, or the tibia, while the writer has produced several good pictures of the adult chest with only a three-inch spark. In general hospital work and practice, however, the average size coil used is an eight or ten-inch one, and with this available spark length all the necessary radiographic and radioscopic work is done, and pictures of most of the deep-seated hard and soft tissues are obtained. For photographic work a small frequency of interruption at the contact breaker is best, while high frequency is more advantageous for direct fluorescent screen work. The question of adapting the contact breaker of a coil to give the rates of frequency required under different conditions of working has, therefore, occupied much time. Mercury contact breakers of different forms have been devised, and with arrangements to vary the rate of frequency of the make and break. Undoubtedly this form of break possesses a great advantage over the ordinary spring form, as with it there is no danger of what is known as "jamming" between the two connecting surfaces, which takes place sometimes in the ordinary break, and which is so fatal to the primary of the induction coil. Mercury breaks, however, are troublesome to work, and the resulting vapour very poisonous, of course. A great point is to have the mercury and the connecting platinum point perfectly clean, and to assure that the latter enters and leaves the former with a perfectly vertical motion. Sparking is much decreased by so doing.

The form of induction coil made by Apps or Apps-Newton has probably up to the present been the most efficient one in use, but it bids fair to be surpassed by a coil recently patented by Mr. A. L. Davis, and which is now about to be put on the market. By a special ebonite disc plan for the insulation of the secondary coil, the spark is considerably increased for the same amount of wire. In an experimental coil there were from thirty to forty sections, each about three-sixteenths of an inch thick, making a total width of just over six inches. With this coil, and using only three accumulators giving six volts in all, a continuous thick spark of ten inches was obtained. One advance with the above arrangement of insulation is that the secondary can be wound right down upon the tube insulating the primary.

When working with an induction coil great care has to be taken, of course, not to pierce the insulation, as that would be fatal; moreover the recharging of the necessary batteries is always a trouble unless one is near a charging station, or can get over the difficulty at home, and these drawbacks are increased very considerably when military field work or other expedition work is being undertaken, and there is no possible chance of getting things rectified once they go wrong.

The Wimshurst machine, as an exciter for X-ray tubes, possesses many advantages over the coil in some respects, and will probably be utilised much more in certain cases and localities. That Wimshurst machines are quite efficient for working X-ray tubes under all conditions and for all purposes has been proved by several investigators. Through the courtesy of Mr. Wimshurst, the writer has had the opportunity of testing the capabilities of the many sized machines in the inventor's possession. These results have shown that, provided the diameter of the plates is not less than twenty inches, very excellent and uniform fluorescent screen illumination is obtained, the rays emitted from the tube in use being of good penetrating value. A tube which previously had been found to be best adapted for a six-inch coil, worked admirably on a machine with four plates of twenty inches diameter. Using higher resistance tubes upon larger machines, and inserting in the circuit a small spark gap suitable to the exhaustion of the tube (the gap varying from one-half inch to one and a-half inches) much better results still were obtained. Further, the work with a Wimshurst machine proceeds noiselessly and without the flickering in the tube so often noticed with coils. The working also entails no more trouble than the mechanical turning of the plates.

At first sight the Wimshurst machine does not seem so portable as the induction coil, but when one takes into consideration the necessary important accessory of the latter, viz.:—the battery and the trouble it incurs—the relative portability of the machine is much increased. Furthermore, the Wimshurst with ebonite plates gives better fluorescent screen results than glass, and ebonite is practically unbreakable; the prime conductors can also be much reduced in size and capacity without affecting the efficiency for X-ray work. Considering, then, that rapid radioscopic work upon the field of battle is of much more importance than radiography, there is no doubt that, so long as the minimum size of plates is attained, and the machine made as compact as possible, it should prove of very great value to the army surgeon.

There only remains one more important practical item to be considered, namely, the vacuum tube for exciting the X-Rays. In principle this remains the same as the "focus" form originally introduced by Professor Jackson, of King's College, in which the cathode rays, emanating from the cathode, impinge upon the anode or anti-cathode and are scattered out through the glass as Röntgen rays. Two difficulties, however, presented themselves. Firstly, under different conditions of working and different spark lengths, the one tube with its one degree of exhaustion and one value of resistance could not be adapted. Secondly, upon continued working it was found that the exhaustion and therefore the penetrating value of the tube increased, so that, finally, in spite of repeated heatings by a flame so as to increase the pressure inside, the resistance of the tube was so high that discharge could not take place under the same conditions it was originally selected for.

These difficulties have been overcome chiefly owing to the persistent, patient work of Mr. A. A. C. Swinton, whose results upon the *modus operandi* in the interior of the tube and also upon the conditions affecting the emission of X-rays have proved of very great importance in the work. Among other things, Mr. Swinton found, with experimental tubes made in his laboratory, that if the anode of the tube be so arranged that the distance between it and the cathode could be adjusted, then a ready and very simple means was at hand whereby the resistance and penetration could be altered to suit the varied conditions imposed. The nearer the anode is placed to the cathode the higher the resistance and consequently the higher the penetration of the tube, and *vice versâ*. In moving the anode of a tube, however, the point of origin of the X-rays is also moved for each adjustment, which is

certainly a disadvantage, especially when a difficult radiograph, requiring a lengthy exposure, is being taken. While, therefore, taking advantage of Mr. Swinton's very useful principle of varying the distance between anode and cathode, Dr. Dawson Turner, in conjunction with the writer, has reversed the arrangement by making the cathode moveable and keeping the anode fixed; and has added a further modification in that the cathode is adjusted by magnetic means, so that movement may be made easily, without disturbing the tube at all, while it is in any desired position. If the tube is constructed so that the cathode, in its movement slides in and out of the side annex blown in the bulb, so as to keep it in proximity to the glass throughout its movement, it is found that the latter has a greater influence upon the resistance of the tube than mere movement to and fro when the cathode is quite out into the bulb space, and affects it in the reverse way; that is, the nearer the cathode is to the anode the lower the resistance, and this increases as the cathode is gradually drawn back inside the annex. The above modifications for the variation in the penetration in the tube are certainly an advance over the older, uncertain methods of potash tubes, &c.

Taking advantage of the fact, first suggested by Prof. S. P. Thompson, that the higher the atomic weight of the anode the higher the penetration of the tube, a further advance has been made by Dr. Mackenzie Davidson, in the use of osmium as an anode. The scarcity of the metal, however, is the one great drawback to its use.

Little has to be said in regard to the fluorescent screen. Potassium-platino-cyanide and barium-platino-cyanide are almost the only salts used, as nothing has yet been found to approach them in efficiency. The latter is preferred on account of the ease in working it. The salt now obtainable is by far purer than that of two years ago, consequently screens are made with much more uniform and brilliant surfaces.

Mention must be made, however, of the great assistance screens offer in shortening the time of exposure, especially of the more inaccessible parts of the body. The salts fluorescing green, however, such as barium-platino-cyanide, are by no means so active as calcium tungstate, which fluoresces blue, and which has, therefore, a greater photographic activity. Placing the fluorescing surface of the screen in contact with the film of the plate, the exposure is, in some cases, reduced to one-fifth of the time otherwise required. Special plates, however, give the best results, and it is difficult to eliminate the granulation of the screen.

What, now, is the mechanism producing Röntgen rays? Do they consist of molecular streams, or are they of the nature of vibrations—transverse or longitudinal? Here we are confronted with a host of hypotheses and theories that would demand much more space than is here possible, to discuss adequately.

Experiments by Röntgen, Battelli, and others, have tended to show that Röntgen and cathode rays are of the same nature, but that the former constitute only part of the latter. The clear distinction, however, between actual similarity is expressed by the absolute non-deviation of Röntgen rays in a magnetic field, while this phenomenon is a strong characteristic of cathode rays. The numerous researches by Swinton and others seem to place beyond doubt the molecular nature of cathode rays, and to prove that they consist of electrified atoms or ions in rapid progressive motion, while the general opinion of physicists seems to be settling towards a wave or ether theory for the Röntgen rays. The difficulty of formulating a perfectly satisfactory theory is great, however, when one has to contend with the fact that there is no direct proof of reflection, refraction, or even polarization of the rays. If polarization could be proved it would simplify matters, as it would show the vibrations to be transversal. The three principal hypotheses under discussion at the present time are:—Firstly, the ultra-corpuscular theory, by Prof. J. J. Thomson; secondly, that the rays are transverse ether waves, and of such excessively short wave lengths that they are an extreme case of ultra violet light; thirdly, the hypothesis of Sir G. Stokes, that they consist of transverse waves in the same manner as light waves, but that they differ from the latter in that they do not form regular trains of wavelets—half a million or more, on the average, in each train—but are solitary waves, each "train" consisting of but one or two wavelets at the most.

The first of these theories is truly a startling one, for it assumes that the atoms of ordinary matter can be pulverized into still finer particles, and that even solid bodies may be penetrated by the flight of such sub-atoms travelling with enormous velocity. It also opens up the question of the divisibility of the atom, which, to say the least of it, is an amazing one to face.

Stokes' theory amounts to this:—That cathode rays consist of negatively charged missiles, shot in showers like hedge-firing, from the negative electrode against a target (the anti-cathode), which receives and suddenly arrests them; and that the Röntgen rays are due to the independent pulses propagated through the ether when the advances of their negative charges are thus abruptly stopped or altered. The radiation from the target reaches the object which is being skiagraphed as an undulation consisting of irregular pulses.

This view has been advanced by Johnston Stoney in analysing these irregular undulations and resolving them into trains of waves of different wave-lengths, among which waves of short wave-length are abundant if the hedge-firing has been sufficiently violent and irregular. The object will then be opaque to the longer waves but transparent to the short ones, and the Röntgen effects follow. This explanation tends to bring Stokes' theory into agreement with the above theory of Sagnac and others, that the rays are of the nature of light waves, but with excessively short, ultra-violet wave-lengths.

HANDICRAFT IN THE LABORATORY.*

GIVEN—a piece of lead glass tubing, two inches in diameter; to hermetically seal in the tube a specimen of chlorine gas in order to display the yellowish green colour: how many chemists or physicists could do it so as to make the specimen presentable on a lecture table or for exhibition in a museum? Such a task demands more skill in craftsmanship than most students are ever able to command. Either traces of the reduced lead, through imperfect management of the oxidizing and reducing flames, will be left in the glass to mar the specimen, or lack of symmetry will appear in the two ends of the sealed tube due to inefficient control of the various forces which tend to alter the shape of the glass while in the plastic condition. A somewhat simpler (though by no means easy) task in the manipulation of the blowpipe is to seal up a specimen of sodium or potassium in vacuo, or in an atmosphere free from oxygen, so as to exhibit and retain the brilliant silvery lustre of these metals when their inordinate propensity for appropriating the vital element is thus held in check. True it is that some

* "Glass Blowing and Working." By Thomas Bolas, F.C.S., F.I.C., etc. (Dawbarn & Ward.) Illustrated. 2s. net.

arts, as far as literary presentation is concerned, are extremely difficult to communicate, and glass blowing is an art of that class; it is, nevertheless, an art of the highest importance to scientific students—more particularly research students—and yet not more than about one in a hundred becomes really proficient in this auxiliary handicraft in the chemical and physical laboratory, while only a very moderate percentage attain tolerable dexterity. Glass working at the lamp, we take it, is, as Mr. Bolas says in the handy treatise before us, "specially calculated to lead to an intelligent study of the reasons for and against various modes of manipulation, and to an appreciation of the importance of economy in effort. . . . To surgical and dental students, as also all students of the more delicate handicrafts, a preliminary training in glass working should be specially useful, especially from the point of view of early acquiring ambidexterity." Practical work in all the sciences rests ultimately on accurate mechanical operations; and however ingenious one may be in original suggestion, he must also be able to execute the needful manipulative work, or somebody must do it for him. That Mr. Bolas is fully conscious of the magnitude of the task he has undertaken may be gathered from a passage on page 10, where he says: "The harmony of action between the two hands of an expert glass worker is probably beyond everything in technology; as, for example, when a longish tube, unequal in diameter at the two ends, is softened in the middle and then operated on, say by blowing in at one end. Not only must the two hands rotate the piece at the same angular rate while before the blowpipe, but each half must be balanced on the hands. When taken from the flame for blowing, the rotation must be maintained, and both hands must move in such exact correspondence as to put no unintentional strain on the soft part." All through the book the author thus indicates difficulties in every detail of the art and suggests means of overcoming them. It is, therefore, very gratifying to come across a work sufficiently practical to make not only a laboratory and workshop guide to the various phases of glass working at the blowpipe, but also, to some extent, technically educational in the real sense of the term—"as leading towards an understanding why each particular operation is done, and as facilitating that interdrift of method from craft to craft which is so conducive to progress." Those who desire to acquire artistic skill in the use of the blowpipe as a modelling tool—a tool acting with equal facility for relief or intaglio—will find ample suggestions in this book, suggestions and instructions which will enable them to model figures, faces, and expressions, as Venetian artists did in days gone by.

THE NEW PLANET DQ.

By A. C. D. CROMMELIN.

IF one were asked to name the optical discoveries which have marked epochs in the history of our knowledge of the solar system, one would probably enumerate, among others, the discovery of Jupiter's satellites, of Saturn's ring, of Uranus, of Ceres and her companions, and of Neptune. The discovery that has now to be chronicled may claim to rank in interest and importance at least as high as that of Ceres, for it has peopled a region of the solar system which has hitherto been regarded as absolutely blank, and has provided our earth with a neighbour whose least distance is only half that of any other heavenly body except the moon.

The discovery of minor planets has advanced so rapidly in recent years that a new one is greeted with but a moderate degree of interest. But the telegram announcing the discovery, on August 13th, by Herr Witt, of the Urania Observatory, Berlin, of a new planet, provisionally designated DQ, was seen at once to have in it something unusual, for the planet was retrograding at the unprecedented rate of half a degree per day, whence it was evident that its orbit must differ in a marked manner from those of the other minor planets. The planet was accordingly carefully followed by a large number of observers during August, and at the beginning of September Dr. Berberich, of Berlin, set to work to determine, as accurately as possible, the orbit of the new body, using for this purpose three observations made by the discoverer on August 14th, 23rd, and 31st. The elements that he deduced are as follows:—

Aphelion passage	1898, June 20d. 443 Berlin mean time.	
Longitude of perihelion ...	122° 17′ 14″	
Longitude of ascending node	303 48 53	
Inclination to ecliptic ...	11 6 57	
Eccentricity	0·22865	
Mean distance from the sun	1·4606	The earth's mean distance from the sun being unity.
Least „ „ „	1·1266	
Greatest „ „ „	1·7946	
Average daily motion ...	2010″·131	

Period = 664·734 days = 1 year 9 months 6 days.

We see from the above that the longitude of the descending node, or point where the planet crosses the plane of the ecliptic from north to south, is 123° 48′ 53″, which is distant only $1\frac{1}{2}$° from the perihelion point; in other words, the planet when nearest to the sun is, at the same time, very near the plane of the earth's orbit, and thus approaches our earth more nearly than it would otherwise do. The following little table gives the least distance of DQ from the earth as compared with those of our other neighbour worlds:—

Object.	Distance from the Earth In astronomical units.	In miles.
The Moon	0·0026	238,000
The Planet DQ ...	0·143	13,300,000
Venus in transit ...	0·264	24,500,000
Mars in perihelion ...	0·372	34,600,000

The fact that makes the new planet so absolutely unique is that its mean distance from the sun is less than that of Mars; there are two or three of the group of asteroids whose perihelion points lie just inside the orbit of Mars; but in all other cases their mean distances considerably exceed his.

Dr. Berberich has compared his elements with all the observations of the planet made during August, and finds a very satisfactory agreement. It will, however, be understood that the planet has not yet been under observation sufficiently long to determine the elements with perfect accuracy, and those given above must be regarded as only a first approximation. It is desirable to keep the planet under observation as long as possible; large instruments will probably be able to follow it till the end of November, or even longer. The following table gives its approximate place at 11h. P.M. on certain days in November:—

Day.	Right Ascension.	South Declination.
November 3rd ...	21h. 1m. 14s. ...	4° 40′
„ 11th ..	21h. 12m. 36s. ...	4° 9′
„ 19th ...	21h. 25m. 29s. ...	3° 19′
„ 27th ...	21h. 39m. 39s. ...	2° 20′

We may thus hope to obtain, even in the present year, a considerably more accurate determination of the orbit; but in the meantime we may provisionally treat the above elements as accurate, and deduce from them some interesting conclusions.

First as to the dimensions of the new planet. It was

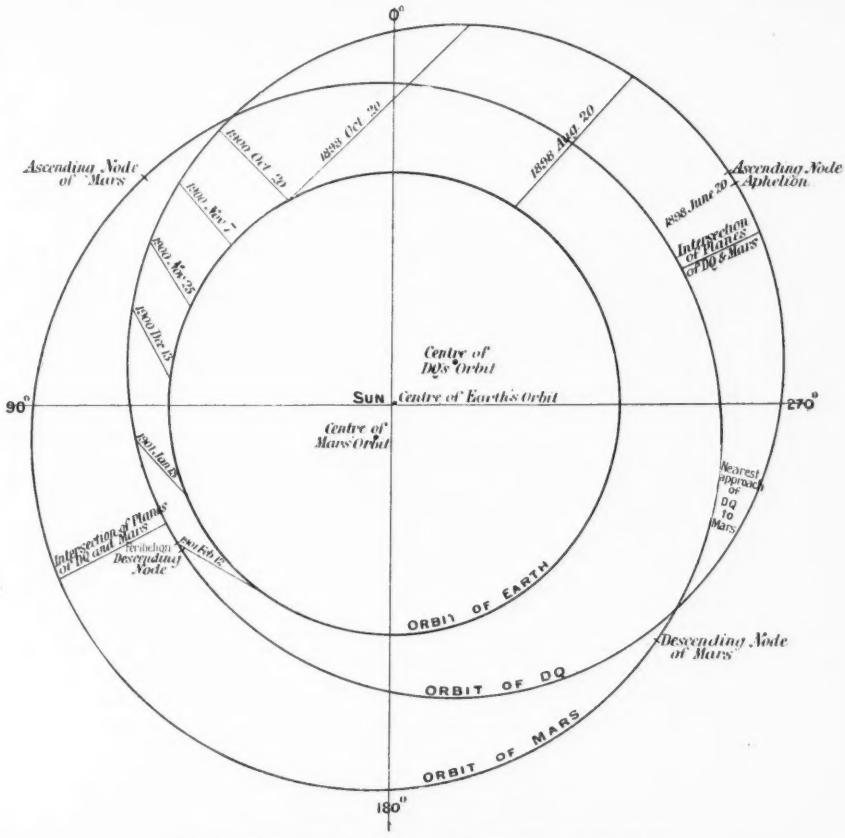
estimated to be of the eleventh magnitude in August, from which, and its distance from the sun and earth at the time, we deduce that its diameter is some seventeen to twenty miles. It is not likely in any case to exceed twenty-five miles, so that when nearest to us its disc will only subtend to us an angle of about $\frac{1}{3}''$, a quantity too small to be measurable even in the largest telescopes. It will, however, at such times, shine as a star of between the sixth and seventh magnitudes, and may thus be visible to keen eyes. It will at its nearest approach be situate in Cancer, which is a very convenient position for northern observers. If its density be assumed the same as that of the moon, its mass is only about $\frac{1}{2,000,000}$ of hers, which is an altogether inappreciable quantity in astronomy.

We now naturally inquire when a favourable opposition will next occur. For this purpose we must have the planet at the nearest point to the sun, *i.e.*, in perihelion, and the earth in the longitude of the planet's perihelion, which is 122° 17′. Now, on reference to the "Nautical Almanac," we find that the earth passes this longitude on or about January 22nd in each year (the longitude of the sun as seen from the earth is 180° greater, or 302°).

We therefore seek a year in which the planet passes through its perihelion on or about January 22nd. We find one perihelion passage by reckoning backwards half the period, or 322·4 days from the aphelion passage on 1898, June 20th, and then we can find others by taking successive intervals of 644·7 days backwards and forwards. The following list of perihelion passage was thus deduced:—

1894, January 21st.	1909, December 11th.
1895, October 28th.	1911, September 16th.
1897, August 3rd.	1913, June 21st.
1899, May 9th.	1915, March 28th.
1901, February 12th.	1917, January 3rd.
1902, November 19th.	1918, October 9th.
1904, August 25th.	1920, July 14th.
1906, May 31st.	1922, April 19th.
1908, March 7th.	1924, January 25th.

We thus see that four and a half years ago an exceptionally favourable opposition occurred. It is much to be regretted that the planet was not detected on that occasion, and it would be worth while for any who possess photographs of Cancer or its neighbourhood taken in January, 1894, to examine them carefully for traces of the planet. It was moving south about $1\frac{1}{3}$ degrees per day, crossing the ecliptic about January 21st, near longitude 122 degrees.



Relative Disposition of the Orbits of Mars, DQ, and the Earth.

An equally favourable opposition will not occur till 1924; it may be noted here that the planet's period is almost exactly $\frac{30}{17}$ths of the earth's; hence it performs seventeen revolutions while the earth performs thirty, and after this period its motions nearly repeat themselves. We may find the synodic period, or average interval between two oppositions, as follows:—In thirty years the earth gains thirteen revolutions on the planet; hence it gains one revolution in $\frac{30}{13}$ years, which is equal to two years and one hundred and twelve days. The next time that the earth overtakes the planet will be in November, 1900, when we shall approach it more nearly than on any other occasion till the year 1917; its least distance from the earth will be some thirty-one millions of miles, which, although more than double what it was in 1894, is yet considerably less than that of Mars at its nearest.

The great value to astronomers of such a near approach lies in the means it gives for improving our knowledge of the sun's distance, the fundamental unit of the solar system. It has already been recognized that the minor planets which approach us most closely afford a better means of determining this than does Mars, in spite of its smaller distance. The method adopted consists of measuring with a heliometer the distances of the planets from a number of neighbouring stars, the measures being made alternately with the planet east and west of the meridian, so that the observer has been carried in the interval by the earth's rotation through a distance of several thousands of miles, and the planet thus appears alternately on one side and on

the other of the place it would have as seen from the centre of the earth. This shift gives the means of deducing the planet's distance from the earth in miles, and the distance of the sun then follows from Kepler's laws. Now, a minor planet, which looks like a stellar point in the telescope, can be measured with much greater precision than can a large, bright, unequally illuminated disc like that of Mars. Dr. Gill's recent determination of the sun's distance (ninety-two million, eight hundred and seventy-four thousand miles), which is probably the most accurate yet made, was based on heliometer observations of Iris, Victoria, and Sappho, whose least distances from the earth (in astronomical units) are 0·84, 0·82, and 0·84 respectively. It will be seen at once what an improvement will be effected when DQ is observed at a distance of 0·14, or only one-sixth of that of the above three planets. In fact, any uncertainty in the sun's distance will be reduced to one-sixth of its present amount. Even the approach in the autumn of 1900, though far from being the most favourable possible, should certainly be utilized for heliometer measures, for its distance will be little more than one-third of that of the three planets measured by Dr. Gill.

Another way in which DQ will assist in improving our knowledge of the sun's distance is by the perturbations which the earth produces on it, which will be very considerable, and which will give an accurate determination of the earth's mass compared with the sun's, and hence of the latter's distance. But this method will not be available for many years; it will, however, in the long run, give very accurate results.

It might at first sight appear that DQ will make still closer approaches to Mars than it does to the earth, but this is not the case; owing to the fact that the orbits are so much inclined to one another, and the unfavourable position of the line where their planes intersect one another (in longitudes 115° and 295°), they do not approach more nearly than 0·23 in astronomical units.

As viewed from Mars the motion of DQ would be very singular, for sometimes Mars would overtake DQ, sometimes it would be overtaken by it, sometimes DQ would be in inferior conjunction with the sun, sometimes in opposition to it, sometimes in Mars' equator, sometimes at his poles.

As viewed from the earth there is one feature in which DQ differs from all the other superior planets; they are in all cases retrograding when in opposition, but DQ when in perihelion has a velocity whose resolved part in the plane of the ecliptic is 18·95 miles per second, while that of the earth in the same longitude is only 18·78 miles per second. DQ is therefore gaining on the earth instead of being left behind, and it will therefore be slowly advancing in longitude; it will have a rapid southward motion in latitude in consequence of its high inclination which will amount to about $1\frac{1}{3}°$ per day. When in opposition near aphelion it will retrograde in longitude $\frac{1}{2}°$ per day as was the case at its discovery; there will necessarily be an intermediate position where it will be exactly stationary in longitude at the instant of opposition, and the earth and planet will travel on side by side with the same velocity, maintaining for some days an almost constant distance.

It has been suggested that DQ may have only recently been introduced into its present orbit by perturbations, but this does not seem to me to be possible if its minimum distance from the earth be 0·14, for the perturbations by the earth at this distance though considerable, would not be able to change the orbit *per saltum*, and the giant planet Jupiter, the great disturber of the minor planets, never approaches DQ more nearly than 3·2, at which distance it would likewise be unable to effect any sudden great change in the orbit.

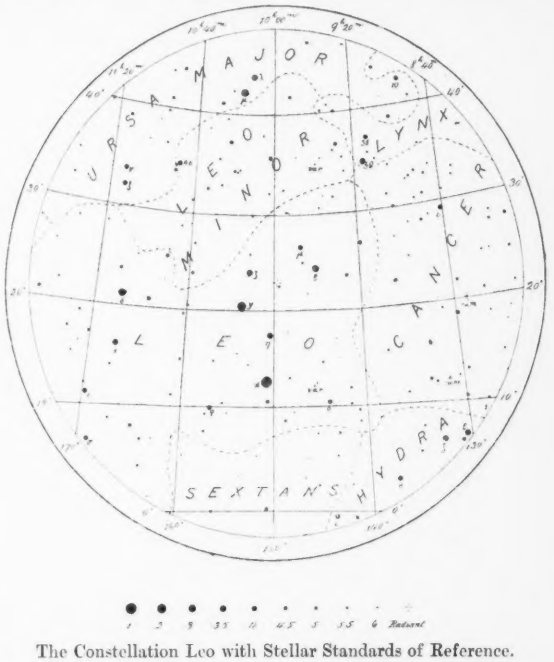
Many of the relations I have referred to above are illustrated in the diagram. To picture the orbits of DQ and Mars correctly, we must imagine them rotated about their lines of nodes through angles of eleven degrees and two degrees respectively. In the case of DQ the upper left hand portion of the orbit will be the highest above the plane of the paper, in the case of Mars the lower left hand portion.

I have now dealt with the relations of the new planet to ourselves as fully as our present knowledge of its orbit appears to warrant. A more accurate computation, based on a larger series of observations, will be awaited with keen curiosity; after which its past and future history may be traced with a closer approach to precision than is possible at present.

THE NOVEMBER METEORS.

PROF. E. C. PICKERING, in Circular No. 31 of the Harvard College Observatory, points out that it is very important that a continuous watch should be kept during the two or three days in which the Earth is passing through the denser portion of the meteor stream. This can only be done by establishing a series of stations in various longitudes, so that during the entire time one or more of these stations shall fulfil the conditions that the radiant point shall be above the horizon and the sun below. The watch should be begun on the evening of November 11th, and continued each night until the shower is clearly past. Prof. Pickering recommends all observers to note the following particulars:—

Name of observer, location of station, post office address, time of beginning and ending of observations,



The Constellation Leo with Stellar Standards of Reference.

interruptions by clouds or other causes, condition of sky, as clear, hazy, passing clouds, &c. He then adds the following directions:—

"The observations most desired are those required to determine the frequency of the meteors. They are of

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NEBULA H V 37 CYGNI.

By ISAAC ROBERTS, D.Sc., F.R.S.

XUM

extreme simplicity, and need only care, system and perseverance. Once an hour, or better once every half-hour, observe and record the time during which ten meteors appear. This is most easily done by noting the time by a watch and at exactly the beginning of a minute looking at the sky, giving it undivided attention and counting the meteors seen, not including those appearing outside of the region covered by the map. If great numbers of meteors appear it may be better to count a larger number, as twenty or even fifty. If the interval between the meteors is long, the number to be counted may be reduced. These observations should be repeated until dawn, or over as long an interval as possible. Between these observations the observer may rest, or may make special observations of individual meteors. Thus, when a meteor is seen, record the hour and minute, the brightness on a scale of stellar magnitudes, – 2, equals the brightness of Jupiter or Sirius; 0, Arcturus or Vega; 2, the Pole Star; 4, the Pleiades; 6, the faintest star visible; the colour, B=blue, G=green, Y=yellow, W=white, and R=red; the class, L=Leonid, if path prolonged would pass through centre of map, N= other meteors. Thus L 5 Y, 12h. 26m., indicates that a Leonid, magnitude 5, yellow in colour, was seen at 12h. 26m. Find by trial beforehand how many seconds are required to make each record. Again, the path of each meteor may be marked upon the map by noting its position in relation to the adjacent stars. Such work can be done equally well elsewhere, and should not interfere with the hourly count mentioned above."

PHOTOGRAPH OF THE NEBULOUS REGION ROUND H V 37 CYGNI.

By ISAAC ROBERTS, D.SC., F.R.S.

THE region, to which the photograph annexed hereto refers, is comprised between R. A. 20h. 51m. 24s. and R.A. 21h. 0m. 43s., and in Declination between 42° 56·5′ and 44° 51′ north. Epoch 1900. Scale—one millimetre to thirty seconds of arc. In the N. G. C., No. 7000, it is referred to as faint, exceedingly large diffused nebulosity.

Some photographs of the region have been taken with portrait lenses, having apertures up to six inches in diameter and focal distance of thirty inches, but the scale of such photographs is too small for showing structural details in a satisfactory manner; two of these were taken by Dr. Max Wolf in the latter half of the year 1891, and were published in KNOWLEDGE.

The photograph annexed was taken with the twenty-inch reflector, and exposure of the plate during two hours and fifty-five minutes on the 10th October, 1896, and it will be seen that the structural details of the nebulosity are delineated upon it on a scale that will enable astronomers in the future to detect, and correlate, any changes that may take place in the nebulosity or in the stars that surround or are involved in it. The whole extent of the nebulosity that appears to be connected, or is in proximity to that shown on the photograph would require a larger plate than this to cover it, but there is no indication of a symmetrical aggregation of the nebulosity such as is visible in the majority of nebulæ that are known to exist in many parts of the sky.

There are several indications of fission, and also some evidence of *loci* of vortical disturbance in different parts of the nebulosity, and therefore much matter of great interest to the astronomers of the distant future is herein recorded.

It will be observed, on close examination of the photograph, that nearly the whole surface area of this vast cloud of nebulosity is covered with stars, ranging in magnitude between the ninth and the seventeenth; but very few of them can, with certainty, be pronounced as being actually involved in, and forming part of, the nebulosity. The hundreds of apparently finished stars are probably placed between us and the nebulosity, and if this be the true inference, what must be its dimensions and distance from the solar system? The answer, if one could be given, would be bewildering, for, so far as it is known up to the present time, not one of the stars referred to has a sensible parallax, and therefore the distance from the earth of the nearest of them would be practically infinite; consequently, if the nebulosity is at a greater distance than the stars, we are left entirely without data to enable us to form even the crudest idea of the extent of this part of space. If the question should be asked: What evidence is there for the assumption that the stars are between us and the nebulosity? my answer would be that, if the stars were beyond the nebulosity, their photo-discs would, on the negative, appear less bright, and their margins be more or less nebulous; whereas only those stars which appear involved in the nebulosity present these appearances. Of course it is a fair subject for argument that those nebulous stars which appear to be involved in the nebulosity are not so in reality, but seem thus because they are beyond it in our line of sight. But this argument is much weakened, if not entirely destroyed, when we find on examination of the negative that those faint, star-like condensations are not only nebulous themselves but they follow the curvatures found in various parts of the nebulosity; thus we are driven to infer that the stars are the nearer bodies to us, and that the nebulosity lies beyond the stars.

Photography has now furnished a considerable amount of evidence in support of the theory—first propounded I think by Sir William Herschel—that the stellar universe which is within the bounds of our aided vision, vast though it be, forms only *one* unit in boundless space; but this is not the opportune time for presenting and discussing the evidence furnished by photography bearing upon this important theory. I may have an opening later on for its discussion.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE ECLIPSE THEORY OF VARIABLE STARS.

To the Editors of KNOWLEDGE.

SIRS,—With reference to Mr. Monck's remark (p. 182) about the title of the article, as above, being misleading, logically, perhaps it may be; but a large majority of the readers of KNOWLEDGE no doubt know that the eclipse theory refers only to the Algol type of star, and the title would not be misleading to such. No one, except perhaps quite a stranger to the subject, supposes the eclipse theory explains the long period variables such as Mira Ceti.

With regard to Mr. Monck's second paragraph, I *did* assume, for purposes of calculation, that the brightness of the star (or stars) was uniform in all parts of the disc, as seen by us. Later on, in the last paragraph but one, I expressly anticipated his point that an obscuring atmosphere would alter the character of the light curve.

Mr. Whichells (p. 183) is quite correct in stating that you can get a continuously varying light curve when the

occulting body, at minimum, has still a portion projected outside the central globe. I stated, however, that I was only dealing with central eclipses. Without going into calculations, which are somewhat operose, and for which I have not just now the time, it can be seen that we can get any variety of curve, from an almost straight line with slight depression in centre to a deeply hollow curve. The first results when only a very small portion of the bright central globe is cut off or obscured, and the last when the occulting body is nearly the same size as the primary, and when, at minimum, a small portion only (as seen from the earth) lies outside the bright globe. To get the exact shape at minimum one would require to calculate the change in light for several positions of the occulting body very close together; in fact, for more frequent intervals.

E. E. Markwick, Col.

LIGHT CURVES OF OCCULTING BODIES.

To the Editors of Knowledge.

Sirs,—On page 183 of the August number of Knowledge is the suggestion of working out the curves for bodies which occult each other, as shown in variable stars. In the case of β Lyræ, this has been done by Prof. G. W. Myers, Urbana, Illinois (University of Illinois), who presented his results at the "Conference," held at the Yerkes Observatory, in 1897, October. The agreement between the Argelander light curve and the Myers theoretical curve was very remarkable. Chas. H. Rockwell.

The Observatory, Tarrytown, New York,
9th August, 1898.

WEASEL AND YOUNG.

To the Editors of Knowledge.

Sirs,—About Midsummer I was talking with a friend in the country, when something crossed the road quite near us. On being followed it resolved itself into an old weasel and a young one; the parent, having seized the latter behind the ear, was leading or dragging her charge at a gallop. The animals disappeared under some loose pieces of wood, and by moving one of these gently I was enabled to secure the young weasel in my handkerchief. This wrapper was afterwards very attractive to the parent, who could detect the odour left by the other, and she came quite boldly all around it, posing in the most interesting attitudes, and with a prettily-earnest expression of face.

On the next day I saw her lead another young one for quite twenty yards along the road. A farmer friend tells me that the old weasels (and foxes also) always lead their young in this particular manner.

It would be interesting to learn whether this habit prevails in the carnivora generally; it does not appear to occur in the vegetable eaters. Charles A. Witchell.

Science Notes.

Acetylene gas was, during last month, put through a somewhat severe ordeal at the Botanical Gardens, Edgbaston, where a garden party assembled to witness a demonstration of the new illuminant there introduced into the houses. Prof. Hillhouse has studied the light from two points of view—injury to plants from evolved gases, and relations with colour. He had failed to see the smallest sign of any of those injurious effects which the combustion of coal-gas had upon plants, while the most critical colours, so far as artificial illuminants were concerned, came out of the ordeal with success—the mixed shades of mauve and magenta being as perfectly displayed as with the arc light, and the various shades of yellow could hardly be more distinguished in ordinary sunlight.

Appalling possibilities for crime were suggested by Sir J. Crichton Browne in his inaugural address to the Pharmaceutical Society this session. A connoisseur of poisons could, by keeping his own microbes, slaughter hundreds of innocent people without the slightest fear of his crime coming to light. Even in a most minute post-mortem examination, many of the comparatively new organic poisons defy detection.

The annual exhibition of the Royal Photographic Society of 1898 does not, we think, mark any decided advance in true photography. There is much in the exhibition that is beautiful, and many of the studies display admirable and clever work, but notwithstanding the general excellence of the exhibits there is not one photograph which can be singled out and branded as a masterpiece. If this forty-third exhibition of the Royal Photographic Society is to be of peculiar benefit to photographers, the benefit should lie in clearing up the vexed question as to whether the unworked photograph is to rank side by side with the "faked" photograph. In this exhibition prominent positions have been given to studies so "worked up" that the veriest tyro can see that shadows, high-lights, and much detail are the result of paint and pencil. The influence of this upon the average photographer, whether he sends in an exhibit, or whether he merely attends the exhibition to learn, must be deleterious.

We learn from a report recently issued by the Board of Agriculture, that the total amount distributed during the financial year, 1897-8, to institutions in this country for agricultural education and research was seven thousand two hundred pounds, as compared with seven thousand in the previous year. Four colleges—namely, University College of North Wales, Bangor; Durham College of Science; University College of Wales, Aberystwyth; and Reading College—each received eight hundred pounds, and the remainder was distributed in varying amounts down to a minimum of fifty pounds. Considering that thirty-two separate counties share in this grant, it will be apparent that experimental work in cultivating the soil in this country is economically performed as far as the Government is concerned.

Some very interesting ornithological news has lately been received from New Zealand. A fourth specimen of *Notornis Mantelli*, a large flightless rail, has been captured. The last specimen of *Notornis* was captured some twenty years ago, and it has long been considered extinct by most people, although a few have clung to the idea that the species yet lived hidden in some of the great marshes of New Zealand. The name *Notornis* was originally given by Owen to some fossil bones discovered in the North Island, New Zealand. In 1849, a few years later, Mr. W. Mantell obtained in the Middle Island a freshly-killed specimen of a flightless rail which was declared to be of the same species as Owen's *Notornis*. A second specimen was obtained in 1851, and a third in 1879. The present specimen was killed by a dog in the bush adjoining Lake Te Anau. The skin and all parts of the bird have been carefully preserved, so that we may look forward to having some exceedingly valuable details concerning this interesting bird. The fact that this fourth specimen was a young female proves that the bird is by no means extinct, and also that it is not easy to find.

Electric traction is likely in the near future to become a new power in the transmission of the "mail." Such an electro-postal line as has been recently proposed would be

a kind of cannon, emitting bullets in the form of cars, which can be stopped instantly at a particular station by simply pressing a button at headquarters. Mr. MacGurty, a well-known engineer, has constructed a small tram line, about two miles in length, along which he can easily run an electric car at the rate of two hundred and forty miles an hour, or four miles a minute. These special railroads, it is suggested, should be built preferably above ground, with stations at frequent intervals, each station being in charge of an electrician, who would receive the whole, or part, of the contents of the car, and also be in communication with neighbouring stationmasters.

During last month the International Conference of Scientific Literature met at the Hotel Métropole, and Professor Rücker, in proposing "Science in all Lands," said that "Science had become the most cosmopolitan of all the professions." The Royal Society has a regular organization for recognizing merit outside the nation to which men belonged, and great scientific triumphs are recognized as being triumphs, not for one nation, but for the world. The Royal Society, in 1864, commenced its catalogue of scientific papers, arranged according to the names of the authors, but a catalogue of subjects would be of even greater utility. Such an undertaking is beyond the power of any one society or country, hence the necessity for international co-operation. It is something to know that the scheme is progressing satisfactorily, and that there is a fair prospect of its being completed in such a way as will tend to cement more firmly than at present the union of international science.

In England the annual military and naval expenditure has increased in the last ten years by nine millions nine hundred thousand pounds, while in the same period the annual education budget has only been increased by about three million pounds. Sums spent for these purposes by the Great Powers show rather interesting results:—

	WAR.	EDUCATION.
England	£40,650,000 ...	£10,140,000
Germany... ...	32,840,000 ...	12,120,000
France	36,570,000 ...	7,920,000
United States ...	16,700,000 ...	36,890,000

Thus, the most civilized nations of the world spend about four pounds in military preparation for every pound in fortifying youth for the battle of life—the United States being one notable exception.

Lord Lister, at the opening of the new Pathological Laboratories, Liverpool, championed the cause of vivisection. "It seemed," said he, "the veriest common sense that the more practically familiar a man was with the structure and working of the marvellously complicated mechanism of the human body the better fitted he was to deal with its disorders. . . . Some, perhaps, might be disposed to object to such researches because they involved the sacrifice of animal life, but this was as nothing compared with what occurred for the supply of food to man. . . . Anæsthetics had come to the aid of experiments on animals. They prevented disturbance from the struggles of the animal, and they bestowed upon the operator the unspeakable comfort of knowing that it felt no pain." Such operations painlessly conducted, it is gratifying to know, have, by indicating the precise functions of different parts of organs, already led to the saving of many human lives.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

ROBINS AND HONEYSUCKLE.—The Robin, like the Marsh Tit, is partial to the red juicy berries of the honeysuckle, and this year several Robins have come to my plant for the fruit. On the other hand, the Sparrows, which actually roost in the honeysuckle and a covering hop, never touch the berries.—CHARLES A. WITCHELL, Eltham.

THE MEMORY OF THE PARTRIDGE.—This year a niece of mine, aged eleven, successfully brought up a brood of ten Partridges, and they flew off three weeks ago. One day last week she joined her father, who was shooting two miles from home, and, to her great surprise, came across the identical covey. They immediately recognized their young mistress, and followed her about from field to field, and the next morning had all returned to their old quarters by the hall door.—JOS. F. GREEN.

Further Notes on Birds observed on the Yenisei River, Siberia. By H. Leyborne Popham, M.A. (*The Ibis*, October, 1898, pp. 489-520.)—In a very interesting article under this title Mr. Popham describes how he found the first nest and eggs of the Curlew Sandpiper.

On the Orcadian Home of the Garefowl (Alca impennis). By Alfred Newton. (*The Ibis*, October, 1893, pp. 587-592.)—In this article Prof. Newton describes what was undoubtedly the true breeding place of the last pair of Great Auks in Orkney. The last of these Great Auks was destroyed in 1813. The breeding place is an islet off Papa Westray, on which Prof. Newton has lately landed, after several abortive attempts, in the company of several friends.

Report on the Movements and Occurrence of Birds in Scotland during 1897. By T. G. Laidlaw (*Annals of Scottish Natural History*, October, 1898, pp. 200-217). This report has been carefully compiled from twenty-four Light Station Schedules, and from schedules and notes from twenty-two other observers in different parts of Scotland.

The Great Sheerwater at St. Kilda (*Annals of Scottish Natural History*, October, 1898, p. 234). Mr. Henry Evans records the capture by some fishermen of a specimen of this bird at St. Kilda on August 7th, 1897.

Baillon's Crake in Caithness (*The Field*, October 8th, 1898).—Mr. W. Arkwright, of Thurso, records that he shot a female of this very rare species at Thurso, in September.

Erratum.—In the October number of KNOWLEDGE, p. 234, the Rev. William Serle's name was unfortunately printed as Scole.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

It really seems as if an effective rat poison will soon be easily procurable. In the bacteriological laboratory attached to the agricultural department of the Russian Government a disease broke out among the rats kept for experimental purposes, and soon spread rapidly among the whole stock. An examination of the spleen and liver of the victims brought to light a new bacillus, which was duly isolated and cultivated, and it has been found that any mouse or rat inoculated with the prepared virus invariably succumbs. Pigeons, rabbits, and other creatures appear to be immune from its effects.

XUM

AN IRISH SUPERSTITION.

By FRANCES J. BATTERSBY.

A QUAINT old book, written by Sir Henry Piers of Insternaght in 1682, and entitled "A Chrorographical Description of the County West Meath," gives the following account of the "Connagh worm," which may prove interesting to some readers of KNOWLEDGE.

"We have a certain reptile found in our bogs called by the Irish the 'Connagh worm.' This is an ugly worm, sometimes as thick as a man's thumb, about two or three inches long, having, as all reptiles have, many short feet, a large head, great goggle eyes and glaring, between which riseth or jutteth forth one thick bristle, in shape like a horn, which is prominent and bendeth forward about three-quarters of an inch. Whatever beast happeneth to feed where this venomous worm hath crept (some say if he do but tread there) is certainly poisoned, yet may be infallibly cured if timely remedy be applied; the case is twofold, yet in effect but one, both proceeding from the very worm itself. Some there are that take this worm and putting it into the hand of a new-born child close the hand about it, tying it up with the worm closed in it till it be dead. This child ever after, by stroking the beast affected recovers it, and so it will if the water wherein the child washes be sprinkled on the beast. I have known a man that thus would cure his neighbour's cattle tho' he never saw them.

"The other method of cure, which I like much better, is by boring an augur-hole in a well-grown willow tree, and in it imprisoning, but not immediately killing the worm, so close by a wooden peg that no air may get in, and therein leaving him to die at leisure. The leaves and tender branches of this tree ever after if bruised in water, and the affected beast therewith be sprinkled, he is cured. The All-wise and Ever-gracious God having thus in his Providence ordered it that not only this venomous reptile, but divers others, and who knows if not all, did we know the right method of using them, should have in themselves their own antidotes, that so we might have a remedy at hand as the poet sayeth—'*Unæ eademque manus vulnus opemque ferat.*'"

The first time I saw the "reptile" it was brought to me by a country girl, who had picked it up by the aid of two sticks as it was crossing a road, as she was afraid to handle it. Subsequently, a friend brought me several specimens taken off a fuchsia in her garden, and there were few seasons for many years in which two or three specimens were not obtained by the first finder, now grown fearless of its "poisonous" powers. Last autumn a neighbouring clergyman's daughter walking near a ditch "saw her little dog barking and snapping at a most curious looking creature with staring goggle eyes."

We made many inquiries amongst our labourers and country folk as to what this so-called "reptile" could be, and the various accounts proved very amusing. One man said "he had seen one years ago, about three inches long, and as thick as two black slugs put together; it had a round head like a cat's, and goggle eyes." He was afraid to touch it as its eyes glared like a frog's, and said it bit or stung cattle, when their heads swelled up, and a man was once bit on the leg, which swelled up, and he nearly died.

A labourer said that once, having taken his dinner to a field, he was going to fetch the tin basin in the evening, when he found a Connagh sitting in it, glaring at him; and this informant, when offered a reward for a specimen, said he would not touch one for ten shillings. The most reliable and graphic account we obtained was from a woman who thirty years ago saw upon a stem of meadow sweet a creature three or four inches in length, almost black, and banded. She let it climb on a stick. "When it stretched itself, its head came to a point like a leech; when it pulled in the front part, the head seemed very large, and the eyes could not be seen. As it crawled towards her they were glaring and banded across in an odd way, and it had a thing like a gooseberry thorn in its tail." It fell off the stick, and when she came home her father reproved her for not having killed the Connagh by smashing it with a stone, "as now it would sting the cattle."

All these accounts pointed to the larva of the elephant hawk moth, and upon a fine specimen having been brought us this season, the last informant at once identified it with the Connagh named by her father. A friend of the writer told her of an old man who brought her a caterpillar of the elephant hawk moth which he called by the dreaded name. It seems certain, then, that the dreaded "Connagh worm" is nothing more than a harmless caterpillar.

There are two models of the "Connagh" in the Dublin Museum at present. They are studded with coloured stones, and supposed to have been used as charms in days gone by.

Notices of Books.

The Mammals, Reptiles and Fishes of Essex. By Henry Laver, M.R.C.S., F.S.A., F.L.S. (London: Simpkin, Marshall & Co., 1898.) This catalogue of the vertebrate fauna of Essex, excluding the birds, will, like all local lists, prove of value to students of geographical distribution. It is published under the *ægis* of the Essex Field Club, being the third of a series of special memoirs for which this enterprising and enthusiastic body of naturalists is responsible. We are glad that Mr. Laver has given considerable attention to the fishes of Essex; there is still room for work in this direction, but though some species will doubtless have been omitted from the catalogue before us, a good beginning has now been made. The publication of the work will certainly encourage the study of natural history in Essex.

Text-Book of Entomology. By Alpheus S. Packard, M.D., Ph.D., Professor of Zoology and Geology at Brown University. (New York: The Macmillan Company.) 18s. net. Professor Packard's volume deals with the anatomy, physiology, embryology, and metamorphoses of insects, and will prove eminently useful to the working entomologist as well as to students in agricultural colleges. It is presumed that the reader already has some knowledge of invertebrate life, and at the outset the relations of insects to other arthropoda are discussed. The whole of the seven hundred and more pages bear evidence to the extent of the knowledge which Prof. Packard has accumulated through thirty years of assiduous labour. Though the greater part of the volume, perhaps, is taken up with minute and careful accounts of technical detail, some of the subjects would, we are sure, prove of the greatest interest to every intelligent reader. Thus, on p. 111 the question of how flies and other insects are able to walk up, or run with the body inverted, on smooth surfaces, is dealt with. A series of instantaneous photographs, showing the mode of progression of a beetle, on p. 112, is another instance of information which would be popular anywhere. The theory of insect flight, exemplified also by instantaneous photographs after Marey, is a charming piece of reading, and these are but a few instances which afford evidence enough that the amateur entomologist will find much in this important volume which he will be able to understand and appreciate.

Text-Book of Zoology. By H. G. Wells, B.Sc. (LOND.), F.Z.S., F.C.P. Revised and enlarged by A. M. Davies, B.Sc. (LOND.) (London: W. B. Clive.) 6s. 6d. The changes which have taken place during the five years since Mr. Wells wrote the first edition of his "Text-Book of Biology"—changes not only in the way in which several of the subjects dealt with in the book are regarded, but also in the syllabus of the Intermediate Science Examination of the London University—have made an extensive revision of the volume desirable. This work has been entrusted to Mr. Davies, a teacher who has had great experience in preparing students for the particular examination the requirements of which the book is designed to meet. While keeping to the original plan and method, Mr. Davies has re-written large parts of the book and superintended the re-drawing of the illustrations. Though written for one examination, and consequently somewhat brief in its exposition of important and interesting questions, the book provides a satisfactory introduction to zoology, and with the help of the remarkably clear figures an intelligent student should find his task easy.

SHORT NOTICES.

The Process of Creation Discovered. By James Dunbar. (Watts & Co.) 7s. 6d. We fear that Mr. Dunbar's treatise has length without breadth. After brushing aside the nebular and meteorite hypotheses as false, baseless, incapable of demonstration, and groundless fictions, he enunciates "the new theory of evolution," in which "the only elements employed or necessary in the formation of the sun, solar system, and universe are those composing atmospheric air and water—the two distinct forms of matter which nature invariably employs in all its works, from the largest suns to the smallest asteroids that exist." Our author has devoted ten years to the formation and suitable presentation of his views on this debatable and interminable subject of the evolution of worlds. Those who have plenty of leisure and sufficient curiosity may extract lively entertainment out of Mr. Dunbar's mental somersaults.

Wireless Telegraphy. By Richard Kerr, F.G.S. (Seeley & Co.) Portraits. 1s. At present a widespread interest prevails in wireless telegraphy, and therefore any readable literature on the subject in handy form is welcome. The book before us has been prepared for busy people who have time to do no more than catch a glimpse of the new inventions which are from time to time subordinated to the routine of daily life. A very vivid picture is given of the unique career of Lindsay, who anticipated by half a century the mode of telegraphy which is now attracting so much attention. The merits of the book from a purely technical point of view may be easily conjectured when it is stated that Mr. Preece has contributed an admirable preface, in which he gives a brief history of the latest discovery of electrical science.

What is Science? By the Duke of Argyll. (David Douglas.) Like many other writers on this subject, the Duke of Argyll recognizes the humiliating limitations of scientific knowledge. Although we may revel in so-called great discoveries, and regard with feelings of pride the wonderful advances made during the nineteenth century, we have after all to reconcile ourselves to the fact that we are as far away from the real divination of Nature's phenomena as were our forefathers—our new positions being only so many blind alleys. The reader who likes occasionally to ponder over and compare the known and the unknown will find the Duke good company, and at the same time see by what means our author arrives at the conclusion that the ratio of our scientific knowledge to the fund of information locked up in Nature's casket is as the one grain of sand is to the number of grains of sand on the earth's surface.

Astronomy for the Young. By W. T. Lynn, B.A., F.R.A.S. (Stoneman.) Illustrated. 6d. It is doubtful whether such a pamphlet as this would make interesting reading to children. The author endeavours in the space of about sixty very brief pages to make clear to young people the elements of astronomy. When we point out that the earth, the moon, the sun, the planets, comets and meteors, and the stars all come in for a share of this restricted territory, it will be apparent how infinitesimal is the first aid here given to the comprehension of so vast a subject. The day has, we think, gone by when the young could be tempted with such a thin intellectual beverage as Mr. Lynn here offers.

Studies in Plant Life. By Eleanor Hughes-Gibb. (Griffin & Co.) Illustrated. 2s. 6d. An endeavour is here made to treat Botany from the optimistic side, and, as such, the book will afford real assistance to those who can derive pleasure from the study of Nature in the open. Technical terms are studiously avoided, and the reader is taught to look upon a flower as a kind of friend. Such a book as this will tend to rouse in the mind that feeling of awe which the wonders of Nature generally inspire when revealed by a teacher who knows how to present facts to the student. The literary style of the book is commendable, and the volume will be found easy reading to all classes of knowledge-hunters.

Teachers who are in the habit of imparting instruction by the aid of natural objects would do well to acquaint themselves with some cabinets of animal, vegetable, and mineral produce put together for this purpose by Messrs. Cox & Co. These cabinets contain from two to three hundred, or more, good specimens of the elements, ores, foodstuffs, manufactured articles, oils, gums, and so on, which are of daily use in life, and each of which, with the aid of notes supplied in a handbook, is sufficient for a lesson. By this arrangement a large amount of material is neatly and orderly stowed away in a presentable case, portable enough to be easily carried about—a system in pleasing contrast with the higgledy-piggledy way in which food for the mind is heaped up in some seminaries.

BOOKS RECEIVED.

Celestial and Terrestrial Globes, in case. (Philips.) 12s. 6d.

The Secret of the Poles. By H. Champion. (White & Pike.) Illustrated. 1s. net.

Diet and Food. By Alexander Haig. (Churchill.) Illustrated. 2s.

Practical Mechanics. By S. H. Wells. (Methuen.) 3s. 6d.

Provident Societies and Industrial Welfare. By E. W. Brabrook. (Blackie.) 2s. 6d.

The Structure and Classification of Birds. By F. E. Beddard, F.R.S. (Longmans.) Illustrated. 21s. net.

Aids in Practical Geology. By Prof. Cole. (Griffin.) Illustrated. 10s. 6d.

Eclipses of the Moon in India. By Robt. Sewell. (Sonnenschein.) 10s. 6d. net.

Second Stage Mathematics. By W. Briggs. (Clive.) 3s. 6d.

The Discharge of Electricity through Gases. By J. J. Thomson, F.R.S. (Constable.) 4s. 6d. net.

The Living Organism. By Alfred Earl. (Macmillan.) 6s.

Social and Political Economy. By Thos. Judge. (Simpkin.) 3s. 6d.

Skiagraphic Atlas. By John Poland. (Smith, Elder.) 5s.

Carpentry and Joinery. By F. C. Webber. (Methuen.) 3s. 6d.

Seismology. By John Milne, F.R.S. (Kegan Paul.) 5s.

Qualitative Chemical Analysis. By Chapman Jones. (Macmillan.) 6s.

The Illustrated Annual of Microscopy. (Percy Lund & Co.) 2s. 6d.

The Reliquary and Illustrated Archæologist. (Bemrose.) 12s.

Skertchly's Geology. Revised by J. Monckman. (Murby.) 1s. 6d.

Report of the South-Eastern Union of Scientific Societies, 1898.

THE SMELL OF EARTH.

By G. CLARKE NUTTALL, B.SC.

A BRIGHT fine evening after a day of rain is one of Nature's compensations. The air is peculiarly sweet and fresh, as though the rain had washed all evil out of it. The mind, relieved from the depressing influence of continuous rain, is exhilarated, and, above all, the strong smell of the earth rises up with a scent more pleasing than many a fragrant essence. In the town, indeed, this earthy smell is often obscured by the bricks and mortar which cover the land, and by the stronger, less wholesome, odours of human life, but in the country it has full sway, and fills the whole air with its presence. Even a slight shower, particularly after drought, is sufficient to bring out the sweet familiar smell of the land and thrust it upon our notice.

XUM

The smell of freshly-turned earth is often regarded by country lovers as one of the panaceas for the ills of the flesh, and "follow a plough-share and you will find health at its tail" has proved a sound piece of advice to many a weakly town-sick one, over whose head the threatenings of consumption hung like the sword of Damocles, though it is possible that it is the fresh air, and more especially the sunshine, which are the saving media, and not the mere smell.

But what do we know about this characteristic smell of the soil? Can we regard it as the mere attribute of the soil as a simple substance, such an attribute as is, for instance, the peculiar smell of leather, or the odour of indiarubber; or can we go deeper and find that it is really an expression of complexity below?

Strangely enough this is the case, for the smell of damp earth is one of the latest signposts we have found which lead us into a world which, until recently, was altogether beyond our ken. It points us to the presence, in the ground beneath us, of large numbers of tiniest organisms, and not merely to their presence only, but to their activity and life, and reveals quite a new phase of this activity. A handful of loose earth picked up in a field by the hedge-row, or from a garden, no longer represents to us a mere conglomeration of particles of inorganic mineral matter, "simply that and nothing more"; we realise now that it is the home of myriads of the smallest possible members of the great kingdom of plants, who are, in particular, members of the fungus family in that kingdom, plants so excessively minute that their very existence was undreamt of until a few years ago.

Some faint idea of their relative size, and of the numbers in which they inhabit the earth, may be gleaned from the calculations of an Italian, Signor A. Magiora, who, a short time ago, made a study of the question. He took samples of earth from different places round about Turin and examined them carefully. In ordinary cultivated agricultural soil he found there would be eleven millions of these germs in the small quantity of a gramme, a quantity whose smallness will be appreciated when it is remembered that a thousand grammes only make up about two and a quarter pounds of our English measure. Thus, a shovelfull of earth would be the home of a thousand times eleven millions of bacteria—but the finite mind cannot grasp numbers of such magnitude. In soil taken from the street, and, therefore, presumably more infected with germs, he calculated that there was the incredible number of seventy-eight million bacteria to the gramme. Sandy soil is comparatively free from them, only about one thousand being discovered in the same amount taken from sandy dunes outside Turin.

But though the workers were hidden yet their works were known, for what they do is out of all proportion to what they are; in fact they perform the deeds of giants, not those of veriest dwarfs. "By their works shall ye know them" might be a fitting aphorism to describe the bacteria of the soil. And the nature of their deeds is widely various, for though the different groups are members of one great family, yet, like the individuals of a human family that is well organized, they have each of them their special vocation. In the spring time, when the sun warms the chilly earth, they act upon the husks that have protected the seeds against the rigours of the winter, and crumble them up so that the seedling is free to grow; they break down the stony wall of the cherry and plum which has hitherto imprisoned the embryo; and then, when the young plant starts, they attach themselves to its roots, assist it to take in all sorts of nutriment from air and soil, and thus help it in its fight through life, and when its course has run they decently bury it. They turn the green leaves and the woody stem and the dark root back into the very elements from which they were built up; they effect its decay and putrefaction, and resolve it into earth again. "Dust to dust, ashes to ashes," is the great life work of the earth bacteria.

But up to the present the fresh smell of the earth, the smell peculiar to it, has not been in any way associated with these energetic organisms, and it is quite a new revelation to find that it is a direct outcome of their activity. Among the many bacteria which inhabit the soil, a new one, hitherto unknown, has been just recently isolated and watched. It lives, as is usual with them, massed into colonies, which have a chalky-white appearance, and as it develops and increases in numbers it manifests itself by the familiar smell of damp earth, hence the name that has been given it—*Cladothrix odorifera*. Taken singly it is a colourless thread-like body, which increases numerically by continuous sub-divisions into two in the direction of its length. It derives its nutriment from substances in the soil, which either are, or have been, touched by the subtle influence of life, and in the processes of growth and development it evolves from these materials a compound whose volatilizing gives the odour in question. This compound has not yet been fully examined; it is not named, nor have all its properties been satisfactorily elucidated, but two facts concerning it stand out clearly. One is that it is the true origin of the smell that we have hitherto attributed to earth simply; and the other, that it changes into vapour under the same conditions as water does. Therefore, when the sun, shining after the rain, draws up the water from the earth in vapour form, it draws up, too, the odorous atoms of this newly-found compound, and these atoms, floating in the air, strike on our olfactory nerves, and it is then we exclaim so often, "How fresh the earth smells after the rain."

Though moisture, to a certain extent, is a necessary condition of the active work of these bacteria, yet the chief reason why the earthy smell should be specially noticeable after the rain is probably because this compound has been accumulating in the soil during the wet period. We only smell substances when they are in vapour form, and since the compound under consideration has precisely the same properties in this respect as water, it will only assume gaseous form when the rain ceases. The bacteria have, however, been hard at work all the time, and when the sun shines and "drying" begins, then the accumulated stores commence their transformation into vapour, and the strong smell strikes upon our senses. For the same reason we notice a similar sort of smell, though in a lesser degree, from freshly-turned earth. This is more moist than the earth at the surface, and hence, on exposing it, evaporation immediately begins, which quickly makes itself known to us through our olfactory nerves.

It may also have been remarked that this particular odour is always stronger after a warm day than after a cold one, and is much more noticeable in summer than in winter. This is because moderate warmth is highly conducive to the greater increase of these organisms, and, in fact, in the summer they are present in far larger numbers and exhibit greater vitality than in the winter, when they are often more or less quiescent.

Two other characteristics of *Cladothrix odorifera* are worthy of notice as showing the tenacity with which it clings to life. It is capable of withstanding extremely long periods of drought without injury; its development may be completely arrested (for water in some degree is a necessity with all living things, from highest to lowest) but its vitality remains latent, and with the advent of

water comes back renewed activity. But besides drought it is pretty well proof against poisons. It can even withstand a fairly large dose of that most harmful poison to the vegetable world, Corrosive Sublimate. Hence any noxious matter introduced into the soil would harm it little ultimately; the utmost it could do would be to retard it for a time.

This, then, is the history of the smell of earth as scientists have declared it unto us, and its recital serves to further point the moral that the most obvious, the most commonplace things of everyday life—things that we have always taken simply for granted without question or interest—may yet have a story hidden beneath them. Like signposts in a foreign land, they may be speaking, though in a language not always comprehended by us, of most fascinating regions, regions we may altogether miss to our great loss, if we neglect ignorantly the directions instead of learning to comprehend them.

THE HOOKS ON THE MANDIBLE OF THE HONEY BEE AND THE GIZZARD OF THE ANT.

By WALTER WESCHÉ.

IN KNOWLEDGE for October, 1895, will be found a drawing from my pencil of the hooks on the mandible of the honey bee, which is the only occasion, so far as the writer knows, that this process has been figured. The hooks are nine in number, and in many mandibles carefully examined I have not found this number to vary; they are absent in the queen and the drone, and in all the wild bees that I have had an opportunity of inspecting. The rib of chitine running across the hollow of the mandible is present, as are also hairs (in some large

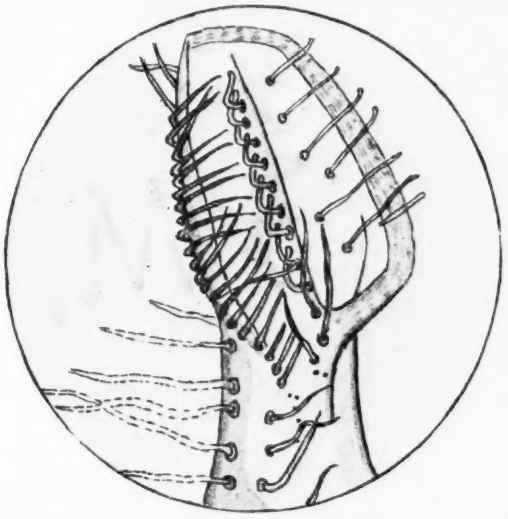


FIG. 1.—Hooks on the Mandible of the Honey Bee (*Apis melifica*) × 140.

humble bees short and bristly), but not in any degree modified to the form of hooks; neither is there any indication of their presence on the mandibles of the common wasp or hornet.

What their use is, is at present unknown. Mr. Frederick Enock says that they are undoubtedly highly specialized, and he "can only wonder at their object." Sir John Lubbock did not know of them, and had no idea as to their use. Mr. T. W. Cowan, to whom I had the pleasure of showing them, now agrees with me that they are hooks, and highly specialized, and says that they possibly may be used in drawing out wax, the mandible undoubtedly being used in cutting it, when forming the comb. I hazarded a suggestion in 1895 that they might be used in clustering, by hooking on to the claws of the bee above, but I understand that this theory is not tenable. Perhaps, after all, they may be of the same use to the bee, as is the iron hook to the man who has lost a hand, and be used in drawing objects out of the hive, or in the care and removal of larvæ—but whatever their use, it must be one of great importance to the worker bee, as otherwise it is impossible to account for their modification—an importance equalling that which has developed the hooks on the wings.

THE GIZZARD OF AN ANT.

This has been many times figured and described. In McCook's most interesting work on the honey ant of California, there is an elaborate drawing of the intestine and gizzard. The drawing here reproduced is from *Lasius niger*, the common black ant of our gardens, seen often stroking and "milking" the aphides. The gizzard is very much the same in appearance as that of the honey ant, but the latter is stated to be chitinous, while the gizzard of *L. niger* seems to me to be calcareous, though I have been unable to verify this by chemical test. It is very brittle, will not take methyl blue stain, and cannot be recommended as a good microscopic object, as the edges will not define, or at any rate I failed to make them. In texture it reminded me of the "dart," in the sexual organs of the common snail.

FIG. 2.—Gizzard of Ant (*Lasius niger*) × 100.

In this case also, the use of the organ is not known; ants are generally supposed to feed on fluids, and I believe a good deal of discussion has taken place at various times on the subject.

The organ consists of four separate parts, the lower portion of each being far less soluble in a solution of caustic potash than the upper—and I have often found the upper part quite dissolved away in the preparation of a whole mounted insect. I have not been able to find the gizzard in the common sugar ant (*Diplorhoptrum domestica*), or in *Myrmica lævinodis*, both of which have stings, though this seems no bar to its presence, as the honey ant has also a sting.

BOTANICAL STUDIES.—VI.

SELAGINELLA.

By A. VAUGHAN JENNINGS, F.L.S., F.G.S.

THE life-history of the little spleenwort, which formed the subject of our last study,* showed that in the true ferns the plant with which we are familiar is the real Sporophyte generation. The fern-plant proper produces no Archegonia and Antheridia, such as our previous examination of the moss might have led us to expect; but a large number of similar spores are developed in simple spore-cases on the

* KNOWLEDGE, September, 1898.

under sides of the fronds. If the spores are allowed to germinate under proper conditions they grow into little green cellular structures, the so-called *Prothalli*, which lead a short but independent existence, form true Archegonia and Antheridia, and constitute, therefore, the real *Oöphyte*, or egg-bearing stage in the life-cycle. In other words, the Oöphyte is a reduced, simplified, and transitory stage in comparison with the highly-specialized, long-lived Sporophyte which we see at its highest in the tree-ferns of the Tropics.

If we look round for other types to help us in tracing the course of development of higher plant-life, we naturally turn first to those relatives of the ferns which are commonly known as the "horse-tails," "club-mosses," "quill-worts," and "pill-worts." Of all these, there is no doubt that we can most easily obtain the information we want from observation of the genus *Selaginella*.

The species included under this name are for the most part spreading, low-growing plants with creeping stems, sending off more or less upright shoots. The structure of their tissues is in general like that of ferns: they have a well developed fibro-vascular system; leaves (usually of two kinds) of several cell-layers in thickness and with distinct midribs; and roots developed on slender cylindrical outgrowths of the stem known as *rhizophores*.

In our own country we have only one species, *S. selaginoides*, which is not uncommon in the moist and rocky parts of our mountain districts. So many foreign species are, however, now in cultivation and easily obtainable, that there can be no trouble in getting material for study. The specific differences are mainly those of leaf arrangement and internal stem structure, and will raise no difficulty in our line of observation. Several of the illustrations here used are of *Selaginella spinulosa*, A. Br., a common species in the Swiss mountains, not unlike our native form in size and general habit.

If we commence, as in the case of the fern, by looking at the mature plant (Figs. I and K), with a view to finding the nature of its reproductive organs, we find that toward the tips of the erect shoot the leaves are closely crowded together, forming spikes or cones.

These leaves do not show any brown groups of spore-cases on their under side like the fern-fronds, but if they are stripped off, or if a section is cut along the axis of the spike, it will be found that they differ from the ordinary leaves in bearing a very distinct sporangium at the inner and upper aspect of the leaf base. Closer observation shows that these sporangia are distinctly of two kinds. Those nearer the tip are transversely oval, single-chambered sacs; green at first, then yellow, splitting across when ripe and discharging a yellow dust (Fig. M). Those nearer the base of the cone are larger, and each consists of four rounded or slightly angular lobes, one resting on the other three in the manner in which the round cannon balls of olden artillery were piled; or, to put it geometrically, the centre of each corresponding in position to one of the solid angles of a tetrahedron.*

Here, then, we meet with a very distinct difference between this plant and the fern. There are two kinds of sporangia instead of one. The next step is to look at the contents of these two sporangia.

At the base of the cone, if it is fairly ripe, some of the "tetrahedral" groups will be found in the act of splitting along the lines separating the four lobes, and it will be seen that each segment contains a single large spore. This spore is rounded externally, but flattened somewhat on the three internal faces where it was in contact with its sister spores, and its external coat is covered by angular projections. The contents of the upper, simple spore-cases appear as a yellow dust; but if this is looked at with a microscope it will be found to consist, not of single spores, but of groups of four, arranged in the same "tetrahedral" fashion as the large ones. There are, then, two kinds of spore as well as two kinds of sporangia. The smaller are termed *Microspores*, and their cases, *Microsporangia*. The larger are known as *Macrospores*, and, similarly, their enclosing envelopes as *Macrosporangia*.*

These fern-like plants with two kinds of spores are called *Heterosporous*, while those with only one kind, such as the true ferns, are known as *Homosporous*. The distinction is not one of merely descriptive value for the purposes of the systematic botanist, but represents a fundamental differentiation of the greatest importance. This will be seen clearly if, as in the case of the fern, we follow the germination and resulting growth of these different spores.

When macrospores have been kept for some time on moist soil, it will be found that the thick protective wall has split, and there is a small projection of soft colourless tissue at the ruptured tip. No green leaf-like cell plates, similar to the fern-prothallus, make their appearance; yet in time young green seedlings of Selaginella, with upgrowing stems, and the characteristic rows of leaves, make their appearance, evidently rising from the macrospore. The fact that such young Selaginella-sporophytes seem to arise directly from a macrospore suggests two possibilities. Either the Oöphyte, or egg-bearing generation, has been entirely lost (in which case we have no explanation of the microspores), or it is so much reduced and concealed as only to be discoverable by careful microscopic investigation. The latter is the true explanation.

Even before the rupture of the spore-wall in germination, the protoplasmic contents of the spore, rich in food materials, will be found to be in part sub-divided by cell walls, forming a definite, if minute and simple, tissue. Similarly, the little colourless papilla which projects from the germinating spore is a distinct cellular outgrowth, and will be found to bear on its margin organs like the archegonia of the fern oöphyte, though less definite in outline and less complete in structure. We have, in fact, a small and simplified prothallus; one that commences its growth within the parent spore; is fed by the food material contained in the spore, never developing roots and green colouring-matter so as to lead an independent existence, but yet containing the egg-cells necessary for the continuation of the plant's being. The diminishing importance of the oöphyte stage observed in the ferns is here carried a step further. The prothallus is no longer a separate and individual plant, but is reduced to a small, colourless group of cells, living at the expense of the food material stored up in the spore.

In the fern it will be remembered that all the spores were alike; that all, on germination, could produce green prothalli; and that all of these were similar, and produced both archegonia and antheridia. It is true that in some genera prothalli are produced which bear only antheridia, but this seems to be only an abnormal condition, changeable by alteration of surrounding conditions, and

* This tetrahedral arrangement results from a difference in the division-planes of the cell from which the spore-group is formed. Thus, if a spherical cell is divided by a transverse wall, and the two segments become rounded off, a pair of cells like a figure eight is produced. If now each of these becomes similarly divided, but one in a horizontal plane and the other in a vertical one, it is evident that the resulting cells will naturally acquire this peculiar grouping.

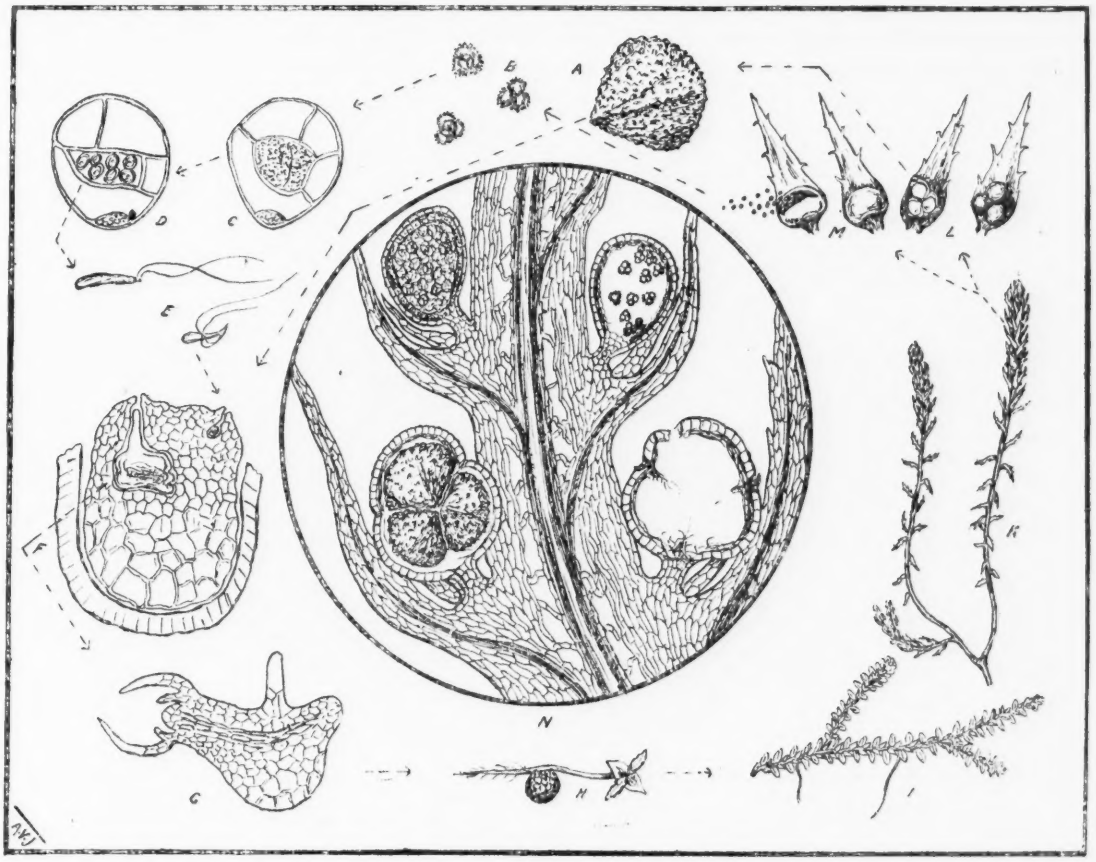
* The terms *Megaspores* and *Megasporangia*, recently introduced, are more classically accurate, but the meaning in this case is identical.

by no means constant. As a general rule one may say that the "homosporous" condition in the ferns is always associated with an independent prothallus, producing both archegonia and antheridia. Here we have large special spores that produce rudimentary prothalli bearing egg-cells.

It is natural, therefore, to turn to the microspores to discover the origin of the spermatoids which fertilize these egg-cells; and it is not difficult to assure oneself that such spermatozoids are developed from the microspores. A very close study of the changes taking place within these spores is necessary to a full understanding of their nature, and requires more elaborate observation. Such examination leads, however, to this conclusion: that the whole contents of the microspore are not used up in the formation of the spermatozoid. The early division of the microspore contents shuts off a portion, the so-called "vegetative cell," which seems to be of no further use. There is still, that is to say, inherent in the spore, the tendency to develop a prothallus-tissue, but this never grows to any extent. It remains merely as a vestige—a remnant of the ancestral cell-tissue on which the antheridia were formed.

The spermatozoids are set free by the breaking of the spore-wall, and the development of the embryo-plants resulting from their contact with the egg-cells can be observed in sections of prothalli in their later stages. The dividing egg-cell soon becomes a definite cell-tissue, in which can be distinguished the young stem growing-point with its first-formed leaves, the commencing root, and a row of cells known as the *suspensor*, which is of interest as occurring here and in higher plants, but not in other cryptogams. The details of development of this little embryo from the egg-cell are very complicated, but for our present purpose we need only note that it can be traced through its various stages to such a form as Fig. H, and that this in turn grows into the Selaginella plant.

The question of the origin of the heterosporous type is full of interest, but we have little evidence to indicate the lines of its evolution. It is impossible to say whether a tendency to differentiation of the spores into two kinds



A.—Macrospore of *Selaginella spinulosa*, A. Br. B.—Microspores of the same species. C. and D.—Stages in the division of a Microspore: the mother-cells of the Spermatozoids in the centre, the "Vegetative," or "Prothallus" Cell at the lower pole. E.—Spermatozoids. (Highly magnified.) F.—Section of a Macrospore after germination, showing the Cellular Mass (Prothallus) produced by the sub-division and outgrowth of its contents. On the right side above is an unfertilized Archegonium, and on the left side a developing embryo, resulting from fertilization of a similar organ. G.—Later stage of an Embryonic Plant. The apical growing point, with a pair of young leaves and ligules, to the left. H.—A young Sporophyte of *S. helvetica*. I. K.—Procumbent and ascending portions of the mature Sporophyte of *S. spinulosa*. The terminal leaves of the up-growing shoots bear the Sporangia at their bases, and are crowded together to form a spike or cone. L and M.—Detached leaves from the fertile spike, showing the Macro- and Micro-Sporangia, entire and dehiscent. N.—Part of a section through a fertile spike of *S. spinulosa*, showing in different stages of development the Microsporangia above and Macrosporangia below. [Fig. C, D, E, after Belajeff; F and G, after Pfeffer; H, after Bischoff. The rest original.]

XUM

brought about the separation of sexes in the prothalli, or if the acquirement of diœcious conditions in the oöphyte stage was followed by modification of the spores. That the establishment of the heterosporous condition dates far back in the world's history is proved by the fossils of our coal-fields, which show that it existed in some of the great tree-like ancestors of Selaginella and its allies, which flourished in the swamps round the Carboniferous seas.

All we can pretend to show in this sketch is that this little mountain "moss," so much less conspicuous than its cousins the ferns, yet contains, for those who care to look at it, the evidence of a great change in organic evolution, which has modified the whole course of plant development, and made our trees and flowers what they are to-day.

It is possible that among the upland districts that form the home of the little Selaginella we may find a better known and more conspicuous member of the plant-world to supply the next link in the chain.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Comet Perrine-Chofardet.—This comet was discovered on September 13th by Perrine, and on the following night by Chofardet. It was visible in the morning sky, and situated a few degrees north of the "sickle" of Leo. Moving rather quickly to the south-east, in the direction of the sun, it was increasing in brilliancy, but assuming a position much less favourable for its observation. It came to perihelion on October 20th, and in November its motion will have carried it so far into the southern sky that it will cease to be visible in our latitude. The following is from an ephemeris by Berberich (*Ast. Nach.* 3520).

Date. 1898.	R.A. h.	m.	Declination. °	′	Distance in millions of miles.	Brightness.
October 18	13	29·8	− 6	10	128	8·7
November 3	15	25·9	27	44	131	4·0
,, 19	17	27·0	38	42	145	1·3
December 5	19	12·5	−40	36	170	0·5

Wolf's Comet is moving slowly to the south-west in Monoceros, but it is a faint object even in powerful telescopes.

The Expected Shower of Leonid Meteors.—The absence of moonlight at the middle of November is a highly favourable circumstance, and a pretty abundant display of meteors should be observed if the weather is clear on the morning of November 15th. In 1832, November 12th, Dawes observed "most astonishingly brilliant meteors from the east, with little intermission for about an hour, when a thick fog supervened." In 1865 many meteors were seen at Greenwich and other places, but the shower could not rank as one of first-class importance. Though 1899 and 1900 will furnish the richest displays, there will be many of these objects seen in the present month. Observations should not be commenced before 11 p.m., as the radiant will not rise until shortly before that hour, and the most brilliant exhibition of meteors will probably occur in the early hours of the 15th. But a look out should be maintained also on the mornings of November 14th and 16th, especially by those observers who wish to study the scientific aspects of the phenomenon. There will probably be more Leonids seen than Perseids in a pretty active return of the August stream; but we are scarcely justified in assuming that the shower will furnish its thousands of meteors as it did in 1833 and 1866, for the earth traverses the orbit at a point considerably in front of the parent comet, and we know that the most profuse distribution of its material lies on the following or rear side of the comet. Those who watch the ensuing return of the meteors will do well to trace them on several nights and to accurately determine their radiant point, horary number, and time of maximum for each date. In *Ast. Nach.*, No. 3516, E. Abelmann, of St. Petersburg, gives the results of his investigation of the orbit of the associated comet (Tempel 1866 I.) and meteoric swarm. He corroborates the previous researches of Adams and Newton, and concludes that the orbits of the meteors and parent comet have nearly coincided with each other from a very remote time. He finds that the longitude of the node is increased 31·5′ during one revolution, or about 1·5° in a century. "As the stream has been observed for about one thousand years, its line of apses has revolved in that time about fifteen degrees, but a glance at the form of the orbit shows that this motion of the apse would alter the solar distance of the stream at the descending node very little from the earth's distance from the sun, so that for many ages yet the continued visibility of the star shower will not be thereby affected. In front of the comet there seems to be no train of dense matter, as at its passage through the node in 1865, the earth was at a comparatively small distance from the comet, and meteors were only remarked in small abundance. At the earth's passage through the node in 1867, again, only a meagre meteoric display was visible." Prof. Abelmann seems to have overlooked the splendid showers of Leonids seen in America both in 1867 and 1868, and has apparently also underrated the strength of the system in that part of the orbit which precedes the cometary nucleus. The observation in 1898 ought to produce important evidence on the latter point.

The Meteoric Shower of Biela's Comet.—This event, so brilliantly presented in 1872 and 1885, and seen in fairly conspicuous character in 1892, may return again in 1898, on November 23rd or 24th. But the period of six years, elapsed since 1892, is less than that of the parent comet, though the year 1898 corresponds with the thirteen-year interval between 1872 and 1885. The average period of Biela's comet, derived from observations between 1772 and 1852, was 6·71 years, but the time was apparently shortening, for between 1772 and 1826 it was 6·76 years, while between 1826 and 1852 it was only 6·62 years. It is most unfortunate that the comet has not been re-observed since 1852, and that we can only judge its exact whereabouts by the most brilliant return of the meteoric system with which it seems to be intimately connected. On November 23rd next the earth will probably become involved in that section of the stream just preceding the comet, and the shower may quite possibly be a very plentiful one, for in 1838 the earth crossed the orbit far in the van of the comet, and yet a rich display occurred. But the precise character of the approaching *rencontre* cannot be defined. The period of thirteen years between the shower of 1872 and 1885 may not apply with equal force to future returns. In 1872 the earth was immersed in the material lying in the wake of the comet, while in 1885 it was involved with that in front of it, so that in 1898 we shall pass yet further in front, and possibly too far in advance of the cometary nucleus to witness a really imposing flight of meteors. If, however, the period of revolution has decreased since 1852, and the meteoric stream is in process of distending itself along the orbit, then a fine display may occur this year. In any case, it should be attentively looked for on the nights of November 23rd and 24th. The moon will be in a gibbous phase, and visible during the greater part of the night. There will, however, be several hours of dark sky

before sunrise, and these should be fully utilized. The radiant point of the shower, being near γ Andromedæ, is visible during the whole night. Prof. Abelmann has recently pointed out, as Schulhof had previously done, that a great disturbance of this system will be felt in 1901–2 by a near approach to Jupiter. The node will be decreased 6·2 degrees, so that a shower will, for some years thereafter, occur on November 17th. In 1904 or 1905 it may be possible to witness the Leonids and Andromedes in simultaneous play. This will provide an interesting event and allow comparisons to be made between the swift streak-leaving meteors and the slow-trained meteors, for the visible aspect of the objects forming the two systems are as widely dissimilar as they can well be. Every meteoric observer will, we are assured, be on the alert on November 15th and 23rd-24th next, in order to gather as many facts as possible of the phenomena that will be displayed. I am inclined to believe that the Leonids will be best seen soon after midnight on the night following the 14th, while the Andromedes will be most numerous just before sunrise on the 24th, or in the early evening of that date.

THE FACE OF THE SKY FOR NOVEMBER.

By A. FOWLER, F.R.A.S.

RECENT experience seems to indicate that the Sun will be well worth careful observation for spots and faculæ, and, in the event of a large spot making its appearance, auroræ may be looked for about the time of its passage across the central meridian.

Mercury is an evening star throughout the month, but he is too far south for easy observation in our latitudes. He will be at greatest eastern elongation (21°) on December **3rd.** On November **20th**, at 8 A.M., he will be in conjunction with Venus, Mercury being 1° 18′ to the north.

Venus is an evening star, but, on account of her great southerly declination, is badly placed for observation after sunset. She will be stationary on the **11th** at 10 A.M., and will afterwards rapidly approach inferior conjunction, which is due on December **1st** at 5 P.M. At the beginning of the month she sets about a hour later than the Sun.

Mars rises late in the evening in the north-east, and, as will be seen from the diagram given last month, he traverses an eastward path through Cancer. During the month his apparent diameter increases from 8·8″ to 11·2″, and his horizontal parallax from 8·4″ to 10·5″. On the **8th** his distance from us will be the same as that of the sun. At the middle of the month 0·9″ of his disc will be illuminated. He will rise about half-past nine on the **1st**, and about eight o'clock at the end of the month.

Jupiter is a morning star, but he is not sufficiently removed from the Sun to permit observations of his satellites before the **12th.** At the middle of the month he rises about two and a half hours before the Sun, his apparent diameter being only 28·8″.

Saturn remains an evening star during the month, but the time of conjunction with the Sun is so near that he can scarcely be regarded as observable to those who have not a perfectly clear horizon to the south-west. At the middle of the month he sets about an hour after the Sun.

Uranus is an evening star until the **25th**, when he arrives at the point of conjunction with the Sun. He may be considered as not observable.

Neptune rises shortly before 7 P.M. at the beginning of the month, and about 5 P.M. towards the end. He is a little more than $1\frac{1}{2}$° north-east of ζ Tauri.

The Moon will enter her last quarter on the **6th** at 2.28 P.M.; will be new on the **14th** twenty-one minutes after midnight; will enter her first quarter on the **20th** at 5.5 P.M.; and will be full on the **28th** at 5.32 A.M. The most interesting occultation during the month will be that of 19 Piscium, Mag. 5·2, which will take place at a convenient time on the **22nd.** The disappearance will occur at 7.9 P.M., at a point 25° east of the north point (30° from vertex); and the reappearance at 8.13 P.M., at 268° east of the north point (260° from vertex).

Conveniently observable minima of Algol will occur on the **17th** at 10.12 P.M.; and on the **20th** at 7 P.M.

Mira Ceti will probably remain a naked eye star throughout the month.

Attention may be called to the recent development of the central condensation of the Great Nebula in Andromeda, which is now well situated for observation. This is not a reappearance of the "new" star of 1885, but is probably a temporarily increased brightness of the central point of the nebula, which is known to be variable.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of October Problems.

No. 1.

(By J. Jespersen.)

1. K to B2, and mates next move.

No. 2.

(By C. Planck.)

Key-move—1. Kt to B6.

If 1 . . . K×Kt (B6),	2. Q to B6ch, etc.
1 . . . K×Kt (Kt6),	2. Q to B4, etc.
1 . . . P (or B) ×Kt (Kt6),	2. Q to K5ch, etc.
1 . . . B×P,	2. Q×KtPch, etc.
1 . . . P×Kt (B6),	2. Kt to R4ch, etc.
1 . . . B to Ktsq, etc.,	2. Q to B4ch, etc.

CORRECT SOLUTIONS of both problems received from H. Le Jeune.

Of No. 1 only, from G. G. Beazley, A. E. Whitehouse, Alpha, W. W. Stead, W. Clugston, W. de P. Crousaz.

Of No. 2 only, from H. S. Brandreth.

[The above pair have evidently proved very difficult. One of the most expert of our solvers at first pronounced the two-mover beyond him.]

Abdul Hamid.—If 1. K to Q3, the Pawn checks.

H. S. Brandreth.—1. P to B7 is met by K to B5.

G. F. T.—After 1. Kt to Kt6ch, K to K3; 2. Kt to Kt5ch is not mate.

Alpha.—The composers should be proud.

A. Firth.—Book of games received with thanks and noticed below.

A. C. Challenger.—Congratulations on your double success. Thanks for the problems. We are inclined to doubt our solvers endorsing your opinion as to the suimate being "not difficult."

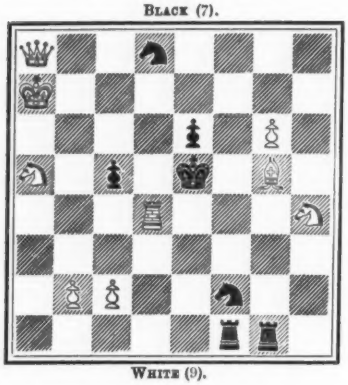
N. E. Meares.—Problems received with thanks. We will examine, and hope to publish them shortly.

PROBLEMS.

No. 1.

By A. C. Challenger.

BLACK (7).



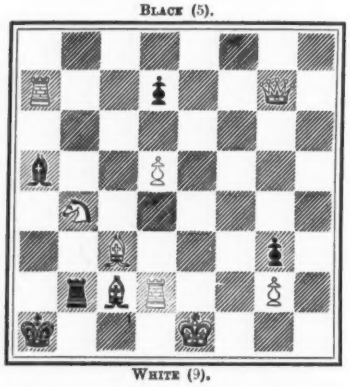
WHITE (9).

White mates in two moves.

No. 2.

By P. H. Williams.

BLACK (5).



WHITE (9).

White compels Black to mate in six moves.

[Black's first three moves are forced; after that there are two variations.]

We have received a little book of sixty pages, entitled "Games of the Counties and Craigside Chess Tournament, 1898." It will be remembered that Mr. A. Burn was the winner of this tournament last Christmas, Mr. Bellingham being second. These two players, in conjunction with Mr. H. E. Atkins, the amateur champion, have annotated nearly the whole of the games in this selection. There is a report of the tournament, and a photograph of all the players engaged. It is an excellent shilling's worth, obtainable at that price from the Hon. Sec., Mr. A. Firth, Bryn-y-Bia, Llandudno.

CHESS INTELLIGENCE.

The Amateur Tournament at Salisbury, promoted by the Southern Counties Chess Union, was successfully concluded on September 20th. The score sheet in Class I. reads as follows:—

J. H. Blake (Southampton)	7½	Tie for 1st and 2nd.
W. Ward (City of London)	7½	
W. H. Gunston (Cambridge University)	7	3rd prize.
G. E. H. Bellingham (Dudley) ...	6	4th prize.
Dr. Bleiden (City of London)	5½	
R. Loman (Metropolitan)	5½	
F. J. H. Elwell (Southampton) ...	5	
C. H. Sherrard (Stourbridge)	4½	
B. D. Wilmot (Birmingham)	3½	
A. Rumboll (Bristol)	2	
A. L. Stevenson (Kent)...	1	

It will be seen that the scoring at the top was extremely close. Mr. Gunston, who played better than he has in public for some time past, led for the greater part of the contest. Mr. Bellingham took some risks against the three players above him, and lost to them all. An accident had also affected his health, and is sufficient to account for his comparatively low position. Mr. Wilmot did not do nearly so well as at Craigside in the winter. The remainder came out roughly in order of merit. In Class II., Mrs. Fagan, of the London Ladies' Club, secured a most creditable victory with the fine score of nine wins and two losses.

It now seems certain that an international tournament will be held in London next year; £500 has already been subscribed. It will probably be a two-round tournament, limited to sixteen or eighteen players.

Mr. Steinitz recently played nineteen games simultaneously at the Hastings Chess Club, winning sixteen and drawing the other three.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 155 (September).

Whale Models at the Natural History Museum. By R. Lydekker, B.A., F.R.S. (*Illustrated.*)
Repetition and Evolution in Bird-Song. By Charles A. Witchell.
The Karkinokosm, or World of Crustacea.—V. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S. (*Illustrated.*)
Economic Botany. By John R. Jackson, A.L.S., etc.
British Ornithological Notes.
Letters. (*Illustrated.*)
Science Notes.
Variable Stars of Short Period. By Edward C. Pickering. (*Illustrated.*)
The Astronomy of the "Canterbury Tales." By E. Walter Maunder, F.R.A.S.
Notices of Books.
"Insect Miners." — II. By Fred. Enock, F.L.S., F.E.S., etc. (*Illustrated*)
Botanical Studies. — V. Asplenium. By A. Vaughan Jennings, F.L.S., F.G.S. (*Illustrated.*)
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.
The Face of the Sky for September. By A. Fowler, F.R.A.S.
Chess Column. By C. D. Locock, B.A.
PLATE.—Copilia Vitrea (Haeckel) and Calocalanus Plumulosus (Claus).

Contents of No. 156 (October).

An Esker in the Plain. By Grenville A. J. Cole, M.R.I.A., F.G.S. (*Illustrated.*)
The Sea-Squirt. By E. Stenhouse, A.R.C.S., B.SC.
The Affinities of Flowers.—The Bladderwort and its Relatives. By Felix Oswald, B.A., B.SC. (*Illustrated.*)
Ethnology at the British Museum. By R. Lydekker. (*Illustrated.*)
The Fourth International Congress of Zoology.
The Great Sunspot. By E. Walter Maunder, F.R.A.S. (*Illustrated.*)
Letter.
Science Notes.
Notices of Books.
British Ornithological Notes. Conducted by Harry F. Witherby F.Z.S., M.B.O.U.
Sunspots and Life. By Alex. B. MacDowall, M.A. (*Illustrated.*)
Economic Botany. By John R. Jackson, A.L.S., etc.
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.
The Face of the Sky for October. By A. Fowler, F.R.A.S.
Chess Column. By C. D. Locock, B.A.
PLATE.—The Great Group of Sunspots of September 3rd—15th, 1898.

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